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Hudson River Steamer Washington Irving

The large side-wheel steamers plying on the Hudson River between New York and Albany are a distinctively American development in naval architecture. Ever since the enterprising inventor, Robert Fulton, demonstrated the commercial success of steam navigation on this waterway over a century ago with his diminutive *Clermont,* the Hudson River, pre-eminently famed among the rivers of the world for its historical associations and the grandeur and beauty of its scenery, has been a fertile field for the exercise of American ingenuity and foresight in the development of a type of shallow draft craft which, in size, convenience and appointments surpass any other boats built for navigating protected waters anywhere in the world.

The new vessel is a magnificent example of this purely American type of naval architecture. She is a unique carrier in every respect, and can rightly be designated as a floating pleasure palace of steel and glass. The design and construction of the boat combine the best scientific, practical and artistic skill of America. The designs were worked out by one of the foremost naval architects, Mr. Frank E. Kirby, together with the firm of J. W. Millard & Bro., of New York.

FIG. 1.—THE LATEST HUDSON RIVER DAY LINE STEAMER, THE WASHINGTON IRVING

From small beginnings the steamship lines which now carry on the immense passenger and freight traffic on this waterway have evidenced a remarkable growth both in the volume of traffic handled and in the magnificent appointments of the boats that are built for this service. During the last seven years no less than three large side-wheel steamers have been added to the fleet of the Hudson River Day Line for passenger service only between New York and Albany, the latest being the *Washington Irving,* just placed in commission.

The hull was constructed by the New York Shipbuilding Company, Camden, N. J., and the machinery by W. & A. Fletcher Company, Hoboken, N. J. The preliminary work in the design of the vessel also included a series of tests with various models in the model towing tank at the University of Michigan, Ann Arbor, Mich., by Professor Sadler, to determine the best form of hull with a minimum of wave-making resistance at high speeds in shallow water. As a result, the novel feature of a torpedo stern was adopted, and the results obtained since the boat has been in service amply justify the pains taken to secure the most economical form of hull.

The *Washington Irving* breaks the world's record for licensed carrying capacity, which was previously held by her consort, the *Hendrik Hudson,* and will transport 6,000 pas-

sengers comfortably at a speed of 23½ miles per hour through the water and have ample room to spare. The vessel is a refined creation from the tip of her graceful stem to her torpedo stern, and is at the same time a staunch and strong craft. Everything on board the ship is planned for the comfort, safety and pleasure of the passengers. No freight is carried, and there are no sleeping rooms on board the ship except the crew's quarters.

The hull, which is 416½ feet long over all, 84 feet beam over guards, 44 feet molded beam, 14 feet 2 inches depth and 8 feet 6 inches draft, is built of steel throughout, the general construction of the hull following very closely that of the *Hendrik Hudson* (described in detail in INTERNATIONAL MARINE ENGINEERING, May, 1906) except in the matter of of fire protection which are provided, the risk of fire on such a vessel is reduced to practically nil.

Propulsion is by steel feathering paddle-wheels, 24 feet 6 inches diameter, each wheel carrying nine buckets 15 feet long and 4½ feet wide. The main engine is a three-cylinder compound inclined engine with cylinders 45, 70 and 70 inches diameter by 84 inches stroke, designed to develop 6,000 indicated horsepower at 38 revolutions per minute. Steam is supplied at 170 pounds pressure by four single-ended boilers, 12 feet 4 inches diameter by 11 feet 11 inches long, and two double-ended boilers, 12 feet 4 inches diameter and 22 feet long, operating under Howden's system of forced draft. The boilers are arranged in two athwartship fire-rooms, with bunkers along each side having a total capacity of 110 tons.

FIG. 2.—REPRODUCTION OF THE ALHAMBRA, USED AS A WRITING ROOM

scantlings, which differ in some respects on account of the difference in the size of the two ships. The framing consists of 4-inch bulb angles, spaced 24 to 30 inches apart, with web frames in compliance with the classification rules. The hull is subdivided by seven transverse bulkheads, and there are five decks, the strength and rigidity of which are secured by means of a system of stanchions between the decks. These are of steel, placed in rows spaced about 10 feet apart, extending practically the whole length of the vessel. By means of connections to the longitudinal girders and deck beams, the entire structure is thoroughly braced to withstand hogging and sagging stresses, thereby doing away with the unsightly hogging girders so prominent in the earlier boats of this class. Steel, asbestos and other fireproof materials are used throughout the hull and superstructure of the boat wherever practical usage will permit, and in all exposed places, such as the fire-rooms, galley, etc. In this way, with the ample means

The average coal consumption is 5 tons per hour. The auxiliaries include two Kerr turbo generating sets of 35 kilowatts each. All of the pumps throughout the vessel are of the Blake make.

The Irving period is made the basis for the interior design of the boat, and nineteen private balcony parlors are provided which are named after the States of Irving's time, while other saloons are modeled from the more artistic interiors of the first half of the last century. Throughout the various saloons will be found about fifty oil paintings sketched by well-known artists from the original locations of the subjects depicted as far as possible. These paintings not only give a peculiar charm to the decoration of the saloons, but they illustrate the life of Washington Irving, his time and his works.

A charming feature is the reproduction of the Alhambra, the relief and coloring of which have been reproduced from careful studies of the original made and adapted to the

FIG. 3.—UPPER DECK, LOOKING AFT

FIG. 5.—PRIVATE BALCONY PARLOR

steamer. Below the main deck, in the forward part of the hull, is a lunch room which has been faithfully patterned after the Old Cock Tavern of Fleet street, London, where Irving and his literary associates used to lunch. In another part of the vessel Irving's study at Sunnyside is copied and used as a ladies' lounge. The main dining room, which takes up the entire after part of the main deck, is furnished in pure Colonial style. The main saloon on the deck above is a blend from Moorish to Knickerbocker, but very tastefully treated. In size this forward saloon is said to be one of the largest rooms afloat.

The chief charm of the boat for the passengers, however, in summer is the immense outside deck area, there being in all about 2 acres of wide promenades and lounging retreats. Large plate-glass windows are fitted to all the rooms, so that a good view can be obtained by each passenger of the wonderful panorama along the Hudson River.

The subjects of the numerous oil paintings which are an attractive feature of the interior decorations of the boat were found entirely in Irving's writings and the scenes of his life. A comprehensive series of views of the Alhambra, painted by Herbert W. Faulkner, are placed in the main saloon. The series include sixteen paintings typifying Irving's long residence in Granada. A large view of Astoria, Ore., as it appeared in its early days when it was a trading post for John Jacob Astor's fur enterprises is found in the main saloon, together with another picture by the same artist, showing Bracebridge Hall on a snowy winter night. A series of eleven views of the Hudson River was supplied by Raphael A. Weed. These views show parts of the river not usually taken as subjects by painters, and for the most part show places of the upper Hudson with its little villages looking just as they did in

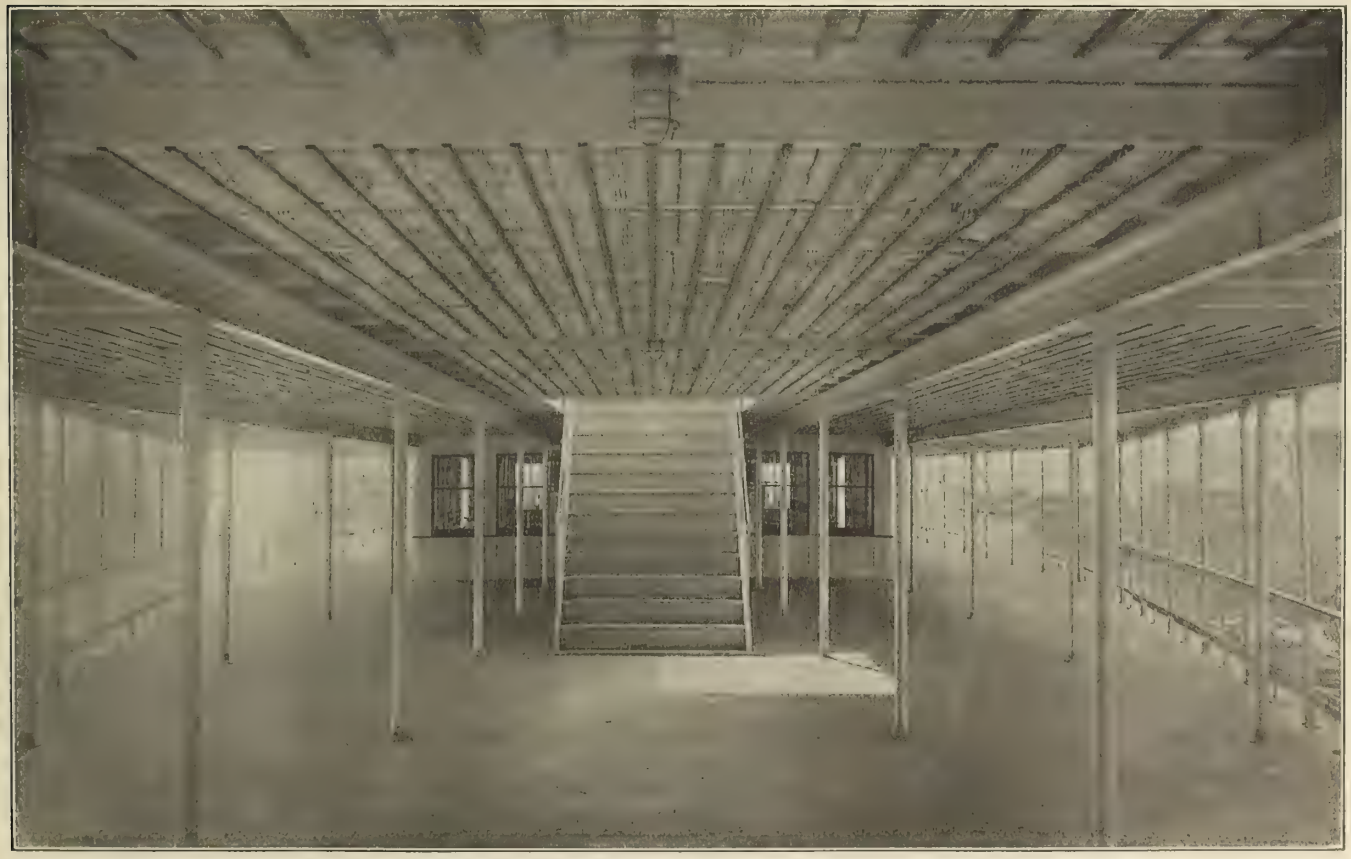


FIG. 4.—VIEW SHOWING WIDE PROMENADE SPACE ON DECK

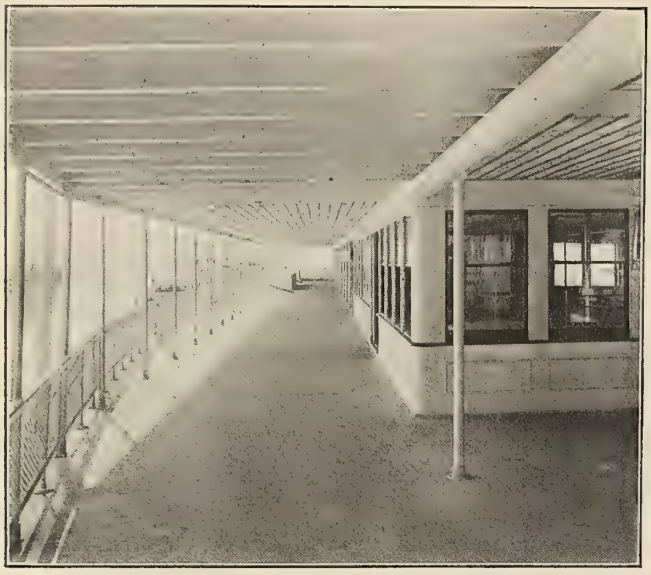


FIG. 6.—OBSERVATION DECK

FIG. 7.—PROMENADE DECK

FIG. 8.—MAIN DECK

FIG. 9.—LUNCH ROOM

Irving's time. One of the paintings, showing a glimpse of the Catskill Mountains from the heights above Castleton, a few miles below Albany, is said to depict one of the most beautiful views in this part of America.

In the main saloon will also be found a series of views painted by Mr. Weed, showing points in New York City associated with different periods of Irving's life, as, for instance, the Golden Hill Inn opposite his birthplace; St. George's Chapel in Beekman street, where he was christened; John Jacob Astor's country home at Eighty-sixth street and the East River, where Irving wrote "Astoria," and the Irving House at Seventeenth street and Irving Place. In the forward observation room, on the uper deck, is a long panoramic view of the Catskills, painted by Mr. Weed, while in the after observation room are paintings of the Sleepy Hollow church and other views. In the large dining saloon on the main deck are two large paintings, one on either side of the main entrance, showing the dining room at Sunnyside, Irving's home on the Hudson, and the dining room of the Red Horse Hotel at Stratford-on-Avon, where Irving lived for a long time.

Another artist whose work is found on the boat is the celebrated sculptor, Victor D. Brenner, who has a bas-relief portrait of Irving.

The commission for most of the paintings depicting the scenes from the Alhambra was given originally to S. Ward Stanton, formerly editor of the *Nautical Gazette,* who painted a number of the decorations for the *Robert Fulton* of the same line. After completing the sketches for these paintings last year, Mr. Stanton sailed for New York on the ill-fated *Titanic* and went down with the ship.

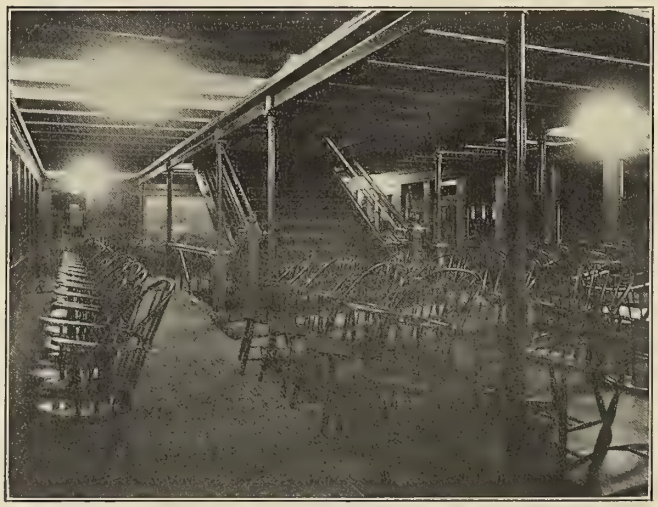


FIG. 10.—OBSERVATION ROOM

Large-Motor Vessels*

For the shipbuilders, and for the whole shipping trade, the large motor vessel question is by far the most momentous one of the day; its importance is as great as was that of the introduction of steam power some 100 years ago, the only difference being that technical improvements now make their way much more rapidly than they did a century ago.

Chief among the many new departures in ship propulsion which the last decade has brought us have been the watertube boiler, the turbine and superheated steam. Of these only the last-named has established itself in the merchant services, the two others being almost entirely confined to war vessels, and here and there only applied to fast passenger vessels. In contrast with these conditions the large motors will at once appeal to the merchant service, although the increase of power which they bring will be of great value to war vessels also.

The stage of development now reached is such that we must give our serious attention to the question, "Will the propulsion of sea-going ships in the near future or within a measurable time be effected wholly or for the most part by means of oil motors instead of by coal and steam?" The economical importance of this question may best be made clear by means of figures. Statistics of the total horsepower now in existence in merchant vessels do not exist, only the annual returns of individual countries in some cases giving the indicated horsepower totals of recent years along with those of the gross register tonnage. From these latter returns it appears that for every 10 gross register tons about 8 horsepower has in recent years been turned out; if a proportion of about 10 to 6 be taken for the whole of the merchant steamer fleets of the world, the engine equipments of the latter will work out at six-tenths of the 37,000,000 gross register tons given by Lloyd's Register, or in round numbers at 22,000,000 of indicated horsepower. The naval fleets of the world are credited in the various statistical compilations with indicated horsepower totaling up to 15,000,000. For the first cost of the engines of merchant steamers $36 (£7-10) per indicated horsepower may be taken as a low estimate, about $12 (£2-10) going to the shafting and to the auxiliary engines and $24 (£5) to the main engines and boilers. The corresponding values for war vessels must be placed higher, so that the total value of the main engines and boilers of sea-going vessels of all kinds amounts in round numbers to $975,000,000 (£200,000,000), which may within measurable time be for the most part rendered worthless by the advent of the oil motors.

A shifting of values of this revolutionary character can be brought about only by very considerable advantages attaching to the new mode of propulsion. In what, then, do the great disadvantages of the propulsion by the steam engine lie? From the point of view of the shipowner and the merchant the disadvantages are not so very great. For commercial purposes the ship is only a means to an end for the shipowner, the engine is only a necessary evil, and the less he hears of it the better he is pleased. For ocean commerce the steam engine fulfills its purpose; it has attained a high degree of reliability, and supplies of coal for it are obtainable at all important towns of the world. In general, then, the position is justified which I have found many managers of shipowning companies take up, that they are not by any means pleased at the prospect of the so-called "improvements," which, in the keen competition of the period of transition, will bring a series of very disturbing alterations in their train.

As has so often been the case in recent times, the movement has been set on foot by the engineers, who are constantly striving after the economically better. The disadvantages of propulsion by the steam engine are of a general character, and lie in the complicated indirect development of power, in which large losses occur by reason of the generation of the steam in the boilers. The endeavors of the engineer, from which the motors have sprung, are directed towards the abolition of this intermediate member and the direct development of power at the point where it is required, namely, in the engine itself.

What are the advantages which thereby accrue to navigation? The abolition of the boilers will be hailed with delight not only by the sea-going and superintending engineers, but also by the captains and owners. The boilers constitute a constant source of care and danger, and require large staffs for their working, the obtainment and management of which are beset with increasing difficulties. Even in the case of an ordinary merchant steamer, the allowances of weight and space for the boilers are considerable, while in large passenger liners and war craft they increase to such an extent as to determine the sizes of the vessels or the speeds of these on given dimensions. The sole reason why the *Mauretania* had to be so much larger than the fast liners of the North German Lloyd Line was that the large horsepower necessary for the attainment of 25½ knots in place of the 23½ knots of a vessel of the size of the *Kaiser Wilhelm II.* entailed an amount of boiler space which could not be obtained otherwise. In addition to the space and weight thus required comes the supply of fuel. As a result of the indirect development of power by the boilers, the average consumption of coal in the best steam installations is still at least 1.3 to 1.55 pounds per indicated horsepower per hour, that in the oil motor with its direct production of power being only about one-third as much.

The great advantages of the motor propulsion as compared with that by the steam engine are, then, the following: Great saving of space and weight in consequence of the abolition of the boilers and of the reduction of the consumption of fuel by one-third; to this comes the elimination of a large proportion of the stoker contingent. A large number of designs which, with the co-operation of the shipowners, have been got out during the last few months for some of the principal types of merchant vessels have shown favorable results.

Compared with a steamer, a motor merchant vessel in the European coasting trade saves about 10 percent in space and weight; in the long-voyage trades, such as those to South America and the Black Sea, the saving ranges up to 20 percent.

A sea-going fishing vessel with a motor can take fuel with her for twice the time that a steamer can, and in addition can make room for about 50 percent more fish.

The most marked differences, however, are shown by fast passenger liners. A fast passenger vessel of the size of the *Kaiser Wilhelm II.* can take in a motor installation of 60,000 indicated horsepower in place of the 40,000 indicated horsepower now carried, and will thereby attain a greater speed than the much larger *Mauretania;* at the same time she can take in sufficient oil in New York for the journey out and home, while under present conditions she has to coal both in Bremerhaven and in New York. Meanwhile, in spite of the 50 percent increase of power and the 100 percent increase of radius of action a considerable saving in weight is effected and the draft is thereby reduced.

Similar results are shown by war vessels, which cannot, however, be further gone into here.

The advantages thus enumerated are so surprisingly great for almost all vessels that the end in view appears worthy of some effort; the only question is whether we are to-day so far advanced that installations of this character can be reliably carried out.

* From a paper read by Professor W. Laas at the III. German Ocean-Navigation Day (III. Deutscher Seeschiffahrtstag), Berlin.

Col. M. B. Adams—A 4-Yard Dipper Dredge

BY ARTHUR F. KING

Last year the United States Government purchased a 4-yard dipper dredge for service on the Wheeling Division of the Ohio River. The machinery of the dredge is designed to have sufficient power to handle properly a 4-yard dipper in ordinary soft material and a 2-yard dipper of extra weight and strength in hard material, when working under a steam pressure of 100 pounds. Arrangements are made for digging to a depth of 25 feet below the surface of the water and all parts are designed with a view to ease in handling and speed in working, so that under ordinary conditions a speed of 40 to 50 seconds per bucket load is maintained, and so that the changing of spuds and moving up is accomplished in about one minute.

FOUR-YARD DIPPER DREDGE IN OPERATION ON THE OHIO RIVER

The hull is built entirely of steel and is 100 feet long, 34 feet beam and 7 feet 3 inches deep. The frame spacing is 24 inches, center to center, the floor and deck beams are 6 inches by 15.6-pound Z-bars; the frames 4-inch by 4-inch by ⅜-inch angles; the intercostal stringers are 4-inch by 4-inch by ⅜-inch angles and are set to support the angle frames. There are five watertight bulkheads distributed throughout the hull; also four longitudinal trusses running the full length of the hull. These trusses are built up of 6-inch by 15.6-pound Z-bars, ⅜-inch gusset plates and 4-inch by 4-inch by ⅜-inch angles. The object of the longitudinal trusses is to impart rigidity to the hull.

The shell plating consists of bottom plates 12.75 pounds, except the outer strake, which are 15.30 pounds; side plating, 12.75 pounds; bilge strake, 15.30 pounds; sheer strake, 15.30 pounds; bow and stern plates, 12.75 pounds; deck plates, 12.75 pounds; except outer strakes, which are 15.30 pounds, and bulkhead plates, 12.75 pounds.

Living quarters for the crew are located on the upper deck.

The hoisting and backing machinery is mounted on a steel frame built up of 24-inch I-beams, securely riveted together and kept in perfect alinement by braces and gusset plates. The engines are double, 13-inch bore by 16-inch stroke, of the horizontal type, the bed plates cast separately and mounted on either side of the under frame in line with the drum shaft bearings. These engines are fitted with a balanced piston throttle and the cylinders are lubricated by means of a force feed oil pump. The engine shaft is of hammered steel, 5½ inches in diameter. The hoisting and backing frictions are of the outside band type, actuated by steam, and the friction bands being lined with wood blocks seldom require adjustment, as the long stroke in the cylinder allows for considerable wear. The backing drum has a smooth barrel mounted on a 6-inch hammered steel shaft, set directly ahead of the engines. The hoisting drum is compound geared from the main engines through the backing shaft. It has a grooved barrel for 1⅜-inch rope and is mounted on a hammered steel shaft 7 inches in diameter. Both of the drums are provided with bronze bushings, removable in case of wear. All gears of the hoisting and backing machinery are of open hearth cast steel and have machine cut teeth.

Swinging Machinery

The swinging machinery is mounted on a steel frame, built up of 20-inch steel I-beams. The swinging engines are double, 9-inch bore by 9-inch stroke, reversible by a central valve of the balanced piston type. The two cylinders with their one steam chest form a single casting, bolted to the bed plate, which is also cast in a single piece. The crank shaft, on one end of which is keyed the cast steel pinion, is of forged steel, 4 inches in diameter. The engines are compound geared to the swinging drum through a 5½-inch hammered steel intermediate shaft, set directly ahead of the engines and fitted with steel gear and pinion. The swinging drum, which is 27 inches in diameter, is grooved for 1¼-inch wire rope and is keyed

to a 5½-inch hammered steel shaft. All gears of the swinging machinery are of open hearth cast steel and have machine cut teeth.

SPUDS AND SPUD MACHINERY

The forward spuds are of oak, in one piece, 25 inches by 25 inches by 50 feet long, reinforced at the corners by 6-inch by 6-inch by ½-inch angles full length. The spuds are operated in steel casings by 1⅜-inch cable connected with the spud drums. Each spud carries two sets of cables, one for hoisting the spud and the other for pinning up the dredge. When the dredge is pinned up the spuds are locked in position by means of a heavy brake band on the spud machinery.

The aft or trailing spud is 20 inches by 20 inches and is raised by a 1-inch cable connected to the aft spud drum and working singly. The spuds are equipped with cast steel points or shoes.

The forward spud machinery consists of two independent outfits, each mounted on a substantial steel frame, built up of 20-inch I-beams. The spud engines, which, in most respects, are similar to the swinging engines, are compound geared to the spud drum through a 5½-inch hammered steel intermediate shaft, set directly ahead of the engines. The intermediate shaft is fitted with a heavy brake band for locking the forward spuds. The spud drum is mounted on a 5½-inch hammered shaft and is grooved for 1⅜-inch wire rope.

The aft spud machinery is mounted on a steel frame, built up of 12-inch I-beams. The engines, which are double, 6-inch bore by 7-inch stroke, and in many respects similar to the forward spud engines, are compound geared to the spud drum through a 3½-inch hammered steel intermediate shaft, fitted with cast steel gear and pinion. The spud drum has a smooth barrel 15 inches in diameter and is mounted loosely on a 3⅞-inch hammered steel shaft. An inside expanding band friction throws the drum out of gear for dropping the spud. A brake band is fitted on the drum for holding the spud in any desired position. All gears and pinions of this machinery are of open hearth cast steel and have machine-cut teeth.

DIPPERS AND DIPPER HANDLES

Two dippers are furnished with the dredge, one of 4 and the other of 2 cubic yards struck capacity. Both dippers are of the most improved construction. The entire front of each dipper is a single manganese steel casting, extending from top to bottom, as well as around the corners, where it is securely riveted to the side plates. The front is fitted with four short teeth or points, no bases being used, since the heavy front castings take the place of the teeth bases. The two sides of the dipper are of ¾-inch plate steel, riveted to the manganese front and to the dipper back, which is a single open hearth steel casting. To the dipper back are secured the dipper handle, pitch braces and door hinges. All pinholes in the dipper subject to wear are provided with removable bushes, those in the door hinges and bail being of manganese steel.

There are two dipper handles, each composed of two oak members 7½ inches by 17 inches by 43 feet long. Each member is ironed with two 8-inch by 7½-inch by ¾-inch angles full length, forming the outside corners, and by two 6-inch by ½-inch bars full length on the inside of the handle. The racking is of manganese steel, bolted to the under side of each member to engage the shipper pinions. The end socket and adjusting castings are bolted to the handle for pin connection to the dipper backs, thus making provision for a change in the pitch of the dippers. The dipper handles are interchangeable and fit both dippers.

BOOM, YOKE BLOCK AND SWINGING CIRCLE

The boom, built entirely of steel, is of the double bow type, 45 feet long between center of sheave at point and center of hinge pin at foot. The point and foot castings are of steel, securely riveted to the sides of the boom. The shipper shaft is of hammered steel, 6 inches in diameter for the yoke block and bearings and 6 inches square for the shipper pinions and brake wheels. The shipper shaft pinions are of manganese steel, engaging the manganese racking on the under side of the dipper handle, the handle being held to these pinions by means of a yoke or saddle block, consisting of a cast steel reach or separator block, joined by two yoke bolts of 3-inch round iron, to a steel frame carrying two sets of steel rollers grooved to clear the racking bolts. The bearings in this block are provided with interchangeable bronze bushes, removable in case of wear. The boom sheaves are 5½ feet in diameter of open hearth cast steel, being bronze bushed and having machine-turned grooves.

The swinging circle is 16 feet outside diameter and is mounted on the bow of the boat, revolving on a steel casting having a journal 45 inches in diameter. The circle is built up of ⅜-inch plates, securely riveted to the hub casting to which the foot of the boom is hinged and to which the cross braces supporting the I-beam rim are fastened. The swinging cables are fitted on the ends with long adjusting bolts to take up the stretch in the rope.

A-FRAME, A-FRAME YOKE AND GUYS

The A-frame is built entirely of steel with cast steel head and foot castings, and stands 34 feet in height above the main deck. The A-Frame is pin-connected to cast steel step castings, set on the forward spud casings. The head casting is of open hearth cast steel and is firmly fastened to the A-frame legs with turned bolts, which are slightly tapered, and is provided with a 7-inch journal pin for the A-frame yoke. The back of this casting has two large lugs to which the A-frame back guys are fastened by means of steel forgings. The A-frame and boom guys are of crucible steel galvanized wire rope, the ends of which are fitted with long U-bolts for adjustment to proper lengths.

OPERATING LEVERS

The levers for controlling the dredging machinery are mounted on the upper deck forward, and are grouped for convenient operation in the small cabin, as shown in the illustration. They include a lever for operating the main hoisting engine throttle valve, for the steam cylinder actuating the main hoisting friction, for the combined throttle and reverse on the swinging engines, for the steam cylinder actuating the friction of the backing drum, for each of the combined throttles and reverses of the forward spud engines, for operating each of the forward spud brakes, a foot pedal for operating the hoisting check band. One cranesman's hand and foot lever are located at the foot of the boom. The aft spud machinery is operated by one friction lever and one throttle lever located on the main deck, aft. The capstan levers are located near the capstans.

BOILER AND FITTINGS

The boiler is of the locomotive type, 72 inches in diameter by 18 feet overall length, having a heating surface of 1,390 square feet. It is designed for a working pressure of 125 pounds, although it is intended to carry about 100 pounds when working. The stack, which is proportioned for natural draft, is 35 inches in diameter and stands 55 feet high from the top of the boiler. The boiler is, of course, equipped with shaking grates and the usual accessories—a 5¼-inch by 3½-inch by 5-inch duplex feed pump and an injector to supply feed water to the boiler. A No. 15 National Heater with 1½-inch feed pipe is placed in the boiler feed line. All steam pipes 1¼ inches and over are connected to the boiler by riveted flanges and all pipes 1¼ inches and over are connected

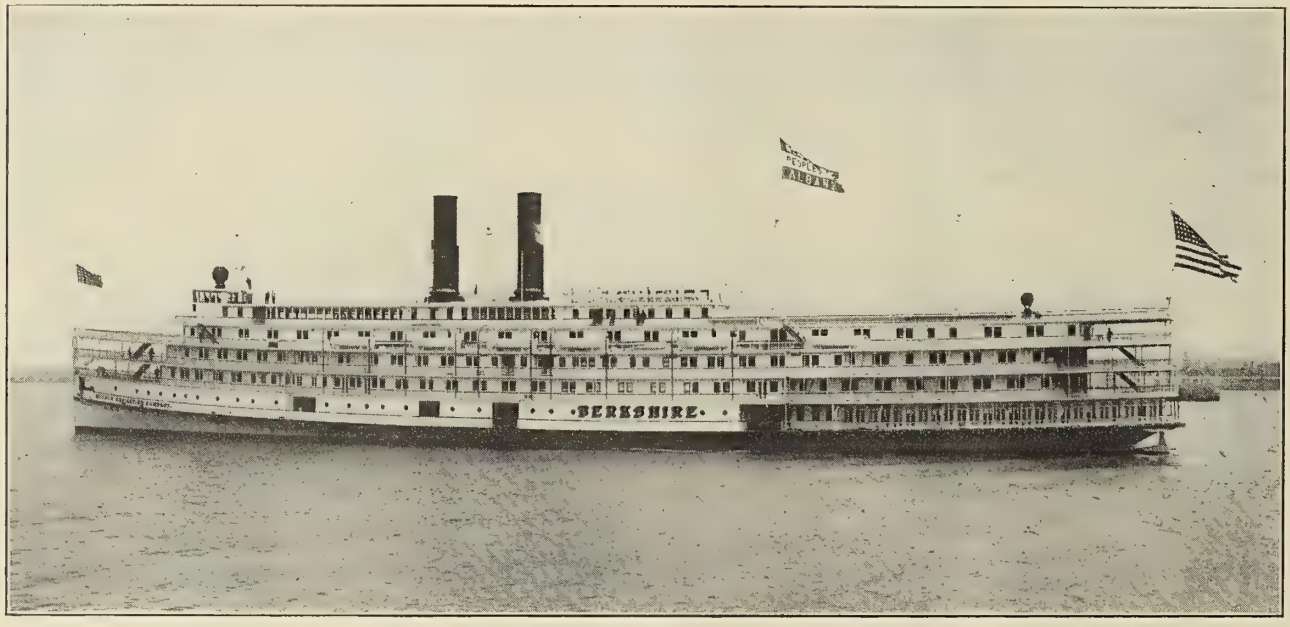
by flanges. Valves under heavy pressure are of extra strength, those of 2½ inches and under being of brass. One 12-inch by 6-inch by 12-inch duplex brass-lined fire and bilge pump is furnished.

A three-ton chain hoist with a built-up steel frame is installed over the engines. The block is rigged up from a double beam running fore and aft above the machinery. This block is used when repairs are being made.

The dredge is used in general river service in which the requirements vary from common soft material to blasted rock, pulling out piling, old piers, etc. For the most part the dredge has served in the latter capacity along with digging recesses for locks. The dredge was built by the Marion Steam Shovel Company, Marion, Ohio.

Hudson River Steamer Berkshire

The latest addition to the splendid fleet of the Hudson Navigation Company, which furnishes night service between New York, Albany and Troy, is the steamer *Berkshire,* designed by J. W. Millard & Bro., naval architects, New York City, and built by the W. & A. Fletcher Company, Hoboken, N. J., by whom the contract for the hull was sublet to the New York Shipbuilding Company, Camden, N. J., and the contract for the joiner work and decorating to Charles M. Englis, successor to John Englis & Son, Brooklyn, N. Y.



NEW STEAMSHIP BERKSHIRE, FOR NIGHT SERVICE ON THE HUDSON RIVER BETWEEN NEW YORK AND ALBANY

The *Berkshire,* which is a five-deck steamer, 440 feet long by 90 feet beam over guards, resembles in general arrangement the other vessels of the Hudson Navigation Company's fleet, such as the *C. W. Morse,* the *Adirondack, Trojan* and the *Rensselaer,* all of which are noted for the artistic manner in which comfort, luxury and elegance have been combined in all the appointments. The passenger accommodation of the *Berkshire* comprises 450 staterooms, including many special suites with parlors and private baths.

Propulsion is by side paddle-wheels of the feathering type, 30 feet outside diameter, each wheel containing twelve curved steel buckets, 3 feet 9 inches wide and 12 feet 11½ inches long. The main engine is a single-cylinder beam surface condensing engine, 84 inches diameter by 144 inches stroke, rated at about 5,000 horsepower. Steam is furnished by four lobster-back return tubular boilers with shells 9 feet 6 inches mean diameter by 34 feet 4 inches long, the front of the boilers being 11 feet 10 inches wide. The allowable safe working pressure is 55 pounds per square inch. The auxiliaries include a donkey boiler, three 50-kilowatt generating sets, furnished by the General Electric Company, and a very complete system of fire, wrecking and sanitary pumps. Protection from fire is secured by steel enclosures around the machinery spaces up to and including the observation deck.

The vessel has five complete decks, designated as the main deck, saloon deck, gallery deck, upper gallery deck, and the observation deck. In the forward hold are berthed the deck hands and firemen. Aft of this a space 40 feet long is reserved for the colored help, and next aft are accommodations for the white help. Abaft these accommodations are the dynamo room, containing three 50-kilowatt generating sets, the boiler room and then the engine room. Immediately abaft the engine room is the galley, and finally at the stern are accommodations for 46 men on the starboard side and for 44 women on the port side.

Above the hold on the main deck are limited accommodations forward for second class passengers, together with toilets and showers. Amidships this deck is left clear for freight and baggage. Abaft the machinery spaces are located the barber shop, purser's office, parcel room and bar. The entire after part of the main deck, for a length of nearly 100 feet, is taken up by the main dining room. This room is fitted with French windows, opening onto the deck, where in pleasant weather tables can be placed for dining in the open air. The dining room is finished in ivory-white with decorative panels.

The saloon and gallery decks are given over almost entirely to staterooms, including the special suites. A space just outside the inside rooms of the gallery deck provides light and air to the inside rooms of the saloon deck below. On the upper gallery deck, besides the staterooms, there is a splendid promenade space outside, and amidships is a ladies' writing room. The forward part of the observation deck is taken up with an observation room, finished in Circassian walnut, opening off from which is a ladies' parlor.

Among the special decorative features is a large panel at the head of the main stairway, containing an oil painting by Clark G. Voorhees of Graylock Mountain in the Berkshires.

New Pacific Coastwise Steamship Congress

The new twin-screw passenger and freight steamship *Congress* for the Pacific Coast Company, to be operated as part of their fleet by the Pacific Coast Steamship Company in the coastwise service between Seattle, Wash., and San Diego, Cal., was launched from the yards of the New York Shipbuilding Company, Camden, N. J., on May 17. The new vessel was christened by Miss Mary Phelps Jacob, a niece of Mrs. William M. Barnum, the wife of the president of the Pacific Coast Company.

The *Congress* is the largest vessel so far built for the sea coasting trade in the United States. She has been specially designed for this service by Mr. George W. Dickie, naval architect and marine engineer, San Francisco, Cal., who has personally superintended her construction in every detail. Her principal dimensions are as follows:

Length over all	441 feet.
Length between perpendiculars	425 feet.
Breadth, molded	54 feet 9 inches.
Depth, molded, to upper deck	29 feet.
Depth of double bottom	3 feet 10 inches.
Depth to main deck	21 feet.
Main deck to upper deck	8 feet.
Upper deck to shelter deck	9 feet 6 inches.
Shelter deck to bridge deck	8 feet.
Bridge deck to boat deck	8 feet 4 inches.

The vessel, except where the design required special treatment, is constructed of steel in accordance with the A-1 20-year rating of the American Bureau of Shipping for vessels with three decks below a poop and forecastle and a shelter deck. She has a straight stem and elliptical stern, a flat keel and double bottom, subdivided by watertight floors and a longitudinal watertight vertical keel plate, fitted complete as water ballast and fresh-water tanks. The double bottom extends from the fore peak bulkhead on frame 12 to frame 144, at which point the inner bottom is raised to the top of the shaft alleys or lower deck, except between the alley bulkheads in the center of the ship forming No. 3 hold, where it is continued on the level of the engine foundations to the after peak bulkhead. The wing spaces under the watertight flat outboard of the shaft alley bulkheads are used for fresh-water tanks for galley, drinking and lavatory purposes; 160 tons of this water is carried. The double bottom extends to the upper turn of the bilge all fore and aft, forming a center line drainage, and is raised at the ends as required by the profile of the vessel.

The *Congress* has two pole masts, rigged as a fore and aft schooner with jib headed sails. There are four main hatches, the two after hatches being trunked through the three passenger decks. No. 2 hatch is trunked between the bridge and shelter decks. This hatch is made large so as to take the longest automobiles, there being room for twenty-four large cars on the upper deck. There are six side hatches on the main deck and two side hatches in No. 2 hold on the lower deck. There are two Otis elevators in No. 2½ hold. There are fourteen side cargo ports and four side passage ports. Four derrick booms are fitted to each mast, the two on the after side of the foremast of steel and capable of handling 15-ton weights. There are eight steam cargo winches and two steamboat winches. The cargo winches are fitted with machine-cut helical gears, made by the Andre Citroen Company, and are expected to run without noise.

FIG. 1.—LAUNCH OF THE CONGRESS

The lower deck is of steel without covering and no camber. The main deck is of steel without covering except in the refrigerating spaces. At the after end, where third class passengers are berthed; this deck is worked flush and covered with linoleum. The upper deck is of steel and is worked flush throughout. In the staterooms this deck is covered with linoleum, also in the spaces aft of the kitchen. In the passages round the boiler enclosures the deck is covered with bitumastic cement. In the main dining saloon this deck is covered with dreadnought tiling, also in the pantry, while the kitchen is laid with special hard tiling. The shelter deck is of steel, and is worked flush throughout. In the staterooms this deck is covered with linoleum and the passages with dreadnought tiling. In the holds this deck is not covered. The bridge deck is framed with steel beams the same as the deck below, and is plated with steel outside of the deck enclosures and covered

with 3-inch pine decking with teak margins. Inside the houses the covering is of 1¼-inch tongued and grooved pine covered with canvas.

Accommodations have been provided as follows: Deck department, 34; engineer's department, 28; steward's department, 83; miscellaneous, 8; total crew, 153. There are accommodations for 416 first class passengers, 120 second class passengers and 150 third class passengers.

The boat deck is entirely of wood, except certain steel framing under the boats, and is wholly covered with No. 2 canvas. Special steel structures are carried up to take the

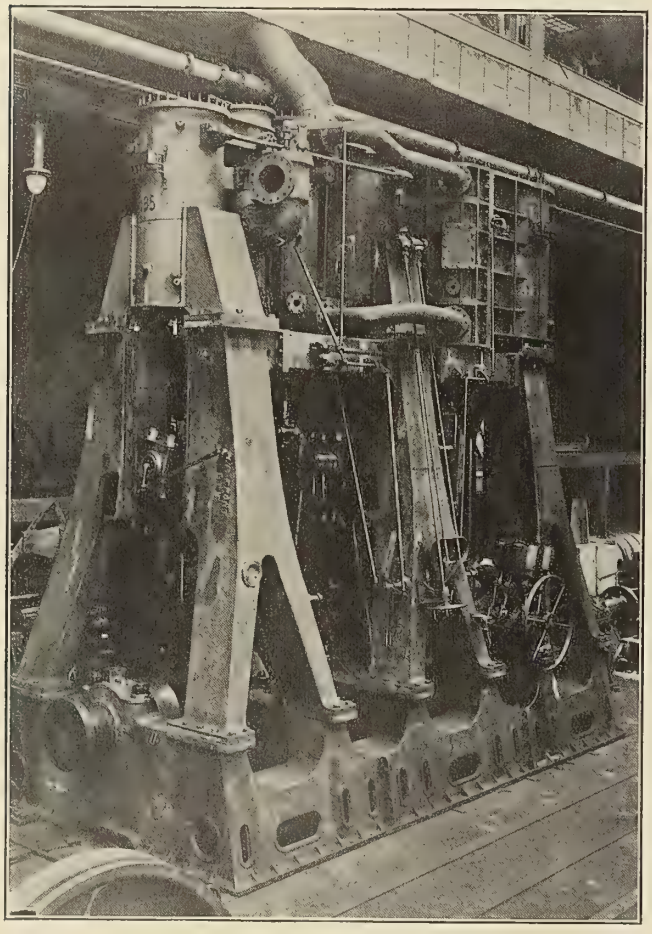


FIG. 2.—ONE OF THE MAIN ENGINES

cargo winches for Nos. 3 and 4 holds, and the winches are set on heavy teak beds. The plank sheers and margin strakes round the hatches on this deck are all of teak.

On the boat deck are the following structures: On the forward end of the boat deck, which commences at frame 52, is a structure containing the captain's quarters and the first class smoking-room. The captain's quarters are finished in mahogany and extend the full width of the house, being 26 feet wide. These rooms are *en suite*, consisting of a bed-room, bath-room and reception room. The first class smoking-room is in Flemish oak, and is furnished with toilets and an enclosed bar. The sides of this house have been worked into alcoves with heavily upholstered settees. The flooring is covered with dreadnought tiling. The heating, here as elsewhere throughout the ship, is done by electricity. Two large heaters of the luminous type are worked into built-in fireplaces with mantels overhead.

Above the smoking-room is the navigating bridge, at the forward end of which is the wheel house. The bridge is entirely closed for a width of 26 feet, with a door on either side opening to the open wings, which extend 4 feet beyond the beam of the ship. Immediately aft of the enclosed bridge is the chart room, with officers' toilet and locker, and aft of the chart room the quarters for the officers, deck engineer and wireless operators.

Aft of the smoking-room, and extending between frames 78 and 85, is the forward deck lounge, forming an entrance for the grand stairway, which extends down through three decks and terminates in the main dining saloon. This room is finished in quartered oak and is carpeted. The stairway is mahogany and the treads covered with dreadnought tiling. Aft of this lounge, and also of the up-take enclosures and the special ventilating trunk from the galley, is the wireless operat-

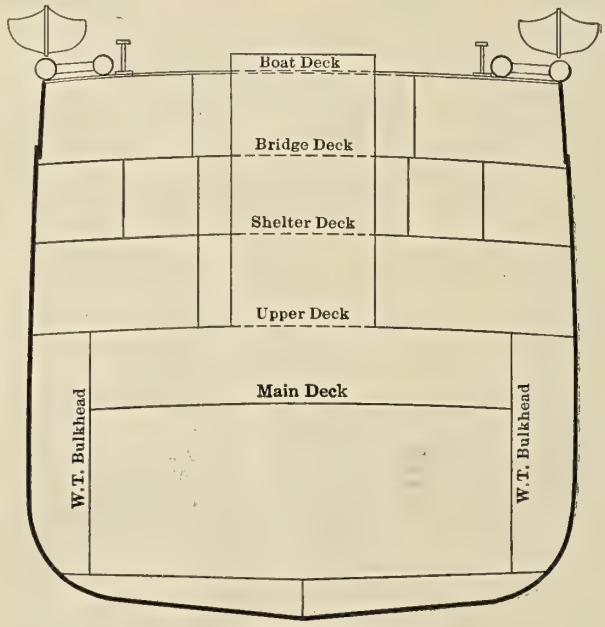


FIG. 3.—MIDSHIP SECTION

ing room and office. Aft of the wireless room and the engine room hatch is the after deck lounge extending between frames 140 and 146, and forming an entrance for the after first class stairway. This room is in quartered oak. At the after end of the boat deck, between frames 160 and 196 and extending the full width of the deck, is the ball room. This enclosure is constructed without stanchions, giving a clear floor for dancing of 35 by 45 feet. Seats are built in around the sides and ends of this room to give the necessary stiffness to the walls.

On the bridge and forecastle deck the house commences on frame 52 and extends to frame 178. Between frames 178 and 180 is a cross passage, completing the first class promenade on this deck, while aft of frame 180 and extending to frame 195 the house is continued to accommodate the public rooms for the second class passengers, who have their own promenade extending from frame 180 to the stern of the vessel.

The forward end of the house on this deck is occupied by the first class lounge, a handsome room finished in mahogany and 40 to 48 feet in size. The forward end of the house is of steel, and the sides are worked into bay windows, housing window seats. The windows are especially large, being 40 inches in depth. Six fireplaces are built into the finish of this room. Just abaft the lounge there are four suites of rooms with private baths and toilets, two in oak and two in mahogany. Aft of the *en suite* rooms are wide entrance halls from the deck outside, all the rooms opening into the inside corridors or lounges. The balance of this house is occupied by forty-four large first class staterooms and two rooms *en suite* with private toilets.

The public toilets on this deck, as on the deck below, are in the center of the ship between the two boiler hatches. A vent enclosure at the center line divides them into two sections.

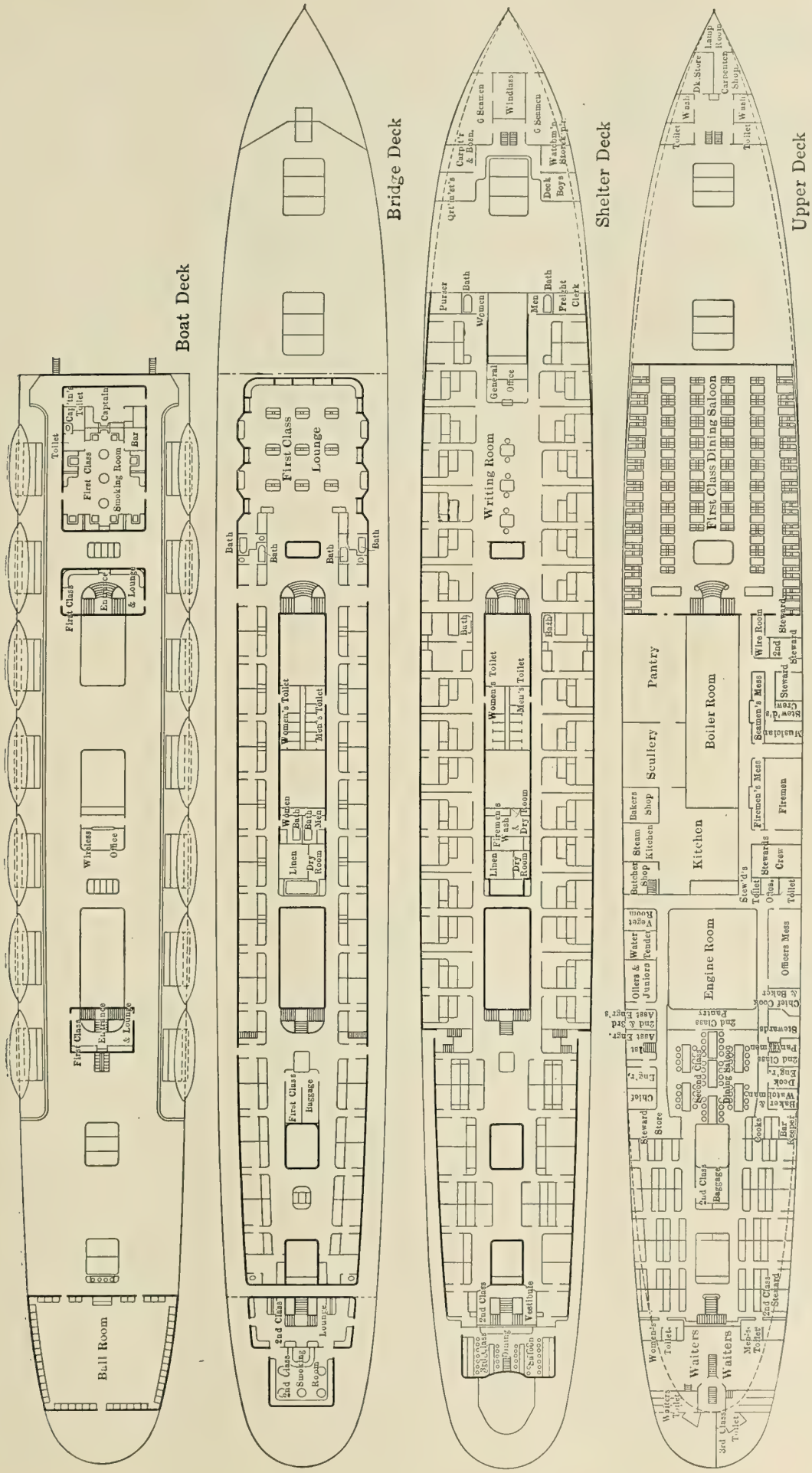


FIG. 4.—DECK PLANS OF THE CONGRESS

All the sanitary piping is run in this vent, which is carried up through the boat deck, where a large exhaust fan draws air from the passenger quarters in the 'midships part of the vessel through the toilets and then up into the open air above.

The second class deck house, aft of frame 180, is occupied by the second class smoking-room and the second class lounge, two comfortable and airy rooms. The lounge, which also serves as an entrance to the second class stairway, which terminates on the upper deck in the second class quarters, is finished in quartered oak and the smoking-room in Flemish oak.

The staterooms on this deck, as elsewhere throughout the ship, are fitted with large wardrobes and heated by electric radiators. A large parcel and hand baggage room is provided on this deck for the use of the first class passengers.

Forward on the shelter deck are the accommodations for petty officers and crew. The crew's quarters are large and the berths only two high. The passenger accommodations on this deck comprise eighty-four first class staterooms and ten *en suite* rooms. The ship's office is located immediately aft of No. 2 hatch enclosure, and is lighted by deck lights from the forecastle deck above. Aft of the office is a large lobby and writing room 20 by 30 feet in size. The sides of the vessel are cut away at frame 143, leaving a promenade for the third class passengers and crew extending from there to the stern. The three classes of passengers carried are thus effectively separated. Aft of frame 184 is the third class dining room and aft of this again the steering engine inclosure. This deck house is entirely of steel.

Forward on the upper deck are located, first, a lamp and paint locker, then a carpenter shop on the starboard side and deck storeroom on the port, then the wash rooms and toilets for the petty officers and crew. From frame 19 to frame 50 is cargo space, which is specially designed to carry automobiles, a large number of which are transported on the Western coast runs.

From frame 50 to frame 85 is the first class dining saloon. This room is entirely fitted with tables for four and accommodates 216. It is finished in mahogany to the lower turn of the cornice and the ceiling is finished white. Deep frames are fitted to compensate for the frames which have been cut in order to form large windows inside the ports. These window frames will be filled with prismatic glass, and the deep frames are extended inboard so as to form alcoves. The lighting fixtures here as elsewhere have been specially designed for the ship.

Aft of the dining room on the starboard side are the quarters of the steward and his first assistant, the wine room and mess rooms for the firemen, sailors, petty officers and licensed officers and berthing space for the firemen. On the port side are located the pantry, scullery, butcher shop, baker shop, steam kitchen and galley. In point of size and equipment the culinary arrangements on this vessel are among the most complete afloat. Aft of the kitchen are accommodations for the engineer's crew and the steward's crew.

The second class staterooms are located on this deck. Each room has four berths, two on a side, with 9 feet 6 inches head room. Here also is the second class pantry and the second class dining room, a handsome apartment finished in quartered oak with built-in sideboards. The extreme after end of this deck is taken up with the quarters for waiters and toilets for the second class passengers.

The third class passengers are berthed on the main deck below, and special movable bulkheads are provided in order to extend or curtail the third class accommodations as required.

The *Congress* is fitted with two sets of triple-expansion, surface-condensing engines, with high-pressure cylinders 28½ inches diameter, intermediate-pressure 46½ inches and low-pressure 78 inches diameter, the stroke being 54 inches. The indicated horsepower will be, collectively, 7,500, at about 86 revolutions, which is expected to drive the ship at a speed of 16½ knots. The propellers are three-bladed, turning outboard. The cylinders are independent of each other, to allow for freedom of expansion. Hard, close-grained cast iron liners are fitted to all cylinder casings. The valve chests are all in the fore and aft center line of the cylinders. The high-pressure and intermediate-pressure cylinders are fitted with piston valves, while the low-pressure valve is a double-ported balanced slide; each valve chest is fitted with the Lovekin improved assistant cylinder. The high-pressure piston is of cast iron and the intermediate-pressure and low-pressure pistons are of cast steel, and the depth of all pistons on the cylinder surface is 12 inches. The high-pressure piston is fitted with a solid plug ring, the surface being grooved for steam packing. The condensers are independent of the main engine frame, the total cooling surface being 12,700 square feet. The crankshafts are of the built-up type, and for each engine are in three interchangeable sections. The reversing gear is of the all-around type, it having advantages for warming up the engines without the danger of moving the ship. This is important where freight is handled up to the last minute.

The air pumps are of the Edwards type, diameter 30 inches, stroke 24 inches, and together with the feed and bilge pumps are operated through levers from the intermediate cross-head. The auxiliary feed pumps are of the Wier type, the water ends being of composition and extra heavy. There are special ballast pumps, fire, sanitary and bilge pumps, also special fresh water pumps for the distribution of fresh water, which is supplied under pressure to every stateroom. There is an automatic oil filtering system fitted. This system collects the oil that has gone through all bearings, pumps it to the filtering system and delivers it back clean to be used over again. There is an auxiliary condenser, feed-water heater and filter.

The electric light, heat and power plant consists of three direct-connected, 110-volt generating sets, each set having a capacity at normal load of 50 kilowatts, and will stand an overload of 25 percent for 25 minutes without undue heating. Each generator is directly connected to a vertical cross-compound engine. There are about 900 incandescent lamps, two 20-ampere searchlights, ten cargo reflectors, four cargo arc lights, three gangway lights, running lights, a complete electric heating system and sixteen motors for fans and kitchen machines.

There are ten single-ended marine boilers, 15 feet inside diameter and 11 feet 10 inches inside length, having in all thirty Morison suspension furnaces, all 48¼ inches outside diameter. The total heating surface of the main boilers is 22,116 square feet. Four main boilers are fitted in the after boiler compartment and six in the forward compartment. They are placed side by side on each side of the ship and arranged to fire athwartships. The two compartments are separated by a watertight bulkhead. There are also watertight longitudinal bulkheads at the backs of the boilers. These bulkheads are entirely independent of the skin of the ship, and are 5½ feet from the outer plating. The boilers are of the Scotch marine type, fitted for natural draft and constructed for a working pressure of 180 pounds. Oil fuel is to be used and the Dahl system has been installed. The oil bunkers will hold 7,500 barrels of oil, sufficient for a round trip from Seattle to San Diego and back.

NAVAL ARCHITECTS' MEETING.—At the summer meeting of the Institution of Naval Architects, held in conjunction with the Institution of Engineers and Shipbuilders in Scotland, at Glasgow, June 23 to 27, the programme of papers presented was concerned chiefly with problems associated with merchant shipbuilding, and was for the most part of a practical nature. Problems associated with the design of merchant ships from the shipowners' and passengers' point of view, metallurgical problems, experimental work at the William Froude tank, and power transmission were the principal subjects discussed.

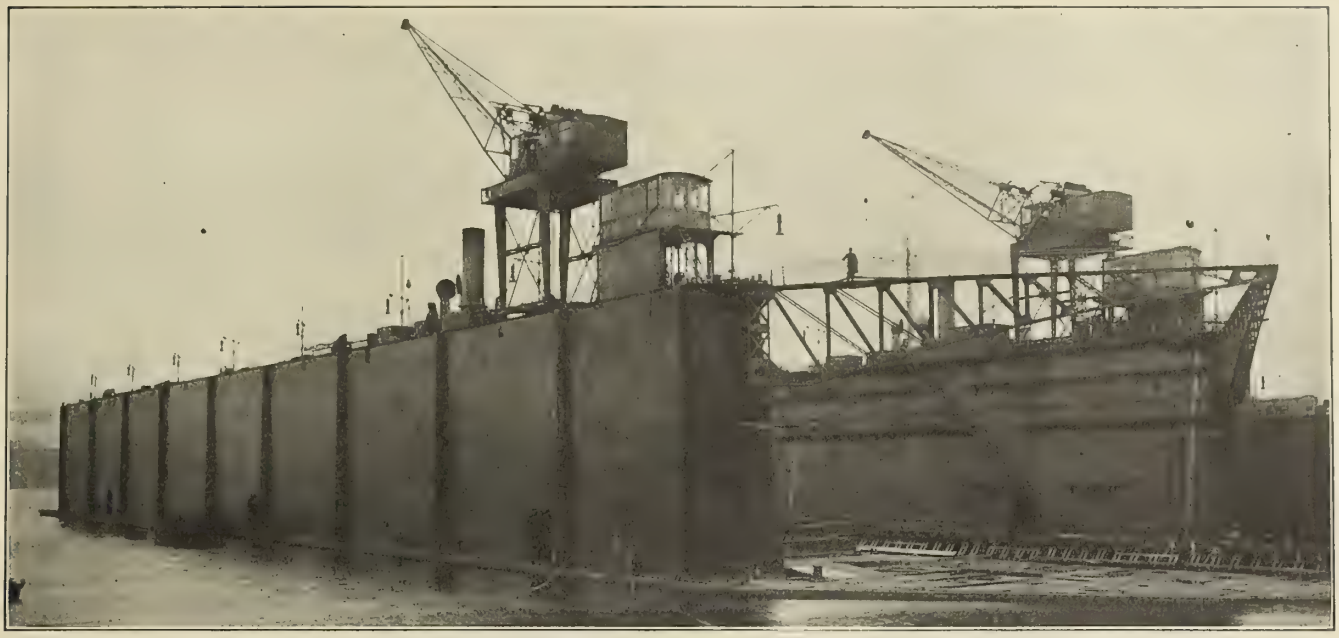


FIG. 1.—BOW VIEW OF 25,000-TON VULCAN DOCK

A German-Built 25,000-Ton Floating Dock

The 25,000-ton floating dock illustrated in the accompanying photographs has recently been constructed by the Vulcan Company, of Stettin, for service at their new shipbuilding yard at Hamburg. This dock is of the bolted sectional type, and was designed by Messrs. Clark & Standfield, naval architects and consulting engineers, of London. In the first place, the dock was originally designed to have four sections, but later the Vulcan Company decided to build only three of the four sections, and this had the effect of lowering the lifting capacity from 35,000 tons to 25,000 tons, and consequently the arrangement of the keel and bilge blocks is as shown in the photographs. The dock is replete with an extensive machinery equipment, and electrical power is generated from a central station on one of the dock sides. A 3-ton crane travels along the side of each wall, and in addition there are four stationary cranes, each ranging from 10 to 30 tons lifting capacity, located conveniently on the side walls.

The length of the dock over all is 525 feet and the width 140 feet, while the clear width inside the dock between the roller fenders is 102 feet. The height from the bottom of the pontoons to the top of the wings is 63 feet 6 inches, and the depth of the pontoons at the centerline is 20 feet. The length of each section is 165 feet, with the exception of the bow section, which is 196 feet long over all. As can be seen from the illustrations, valve houses are located at one end of each wing, while the boiler rooms are amidships.

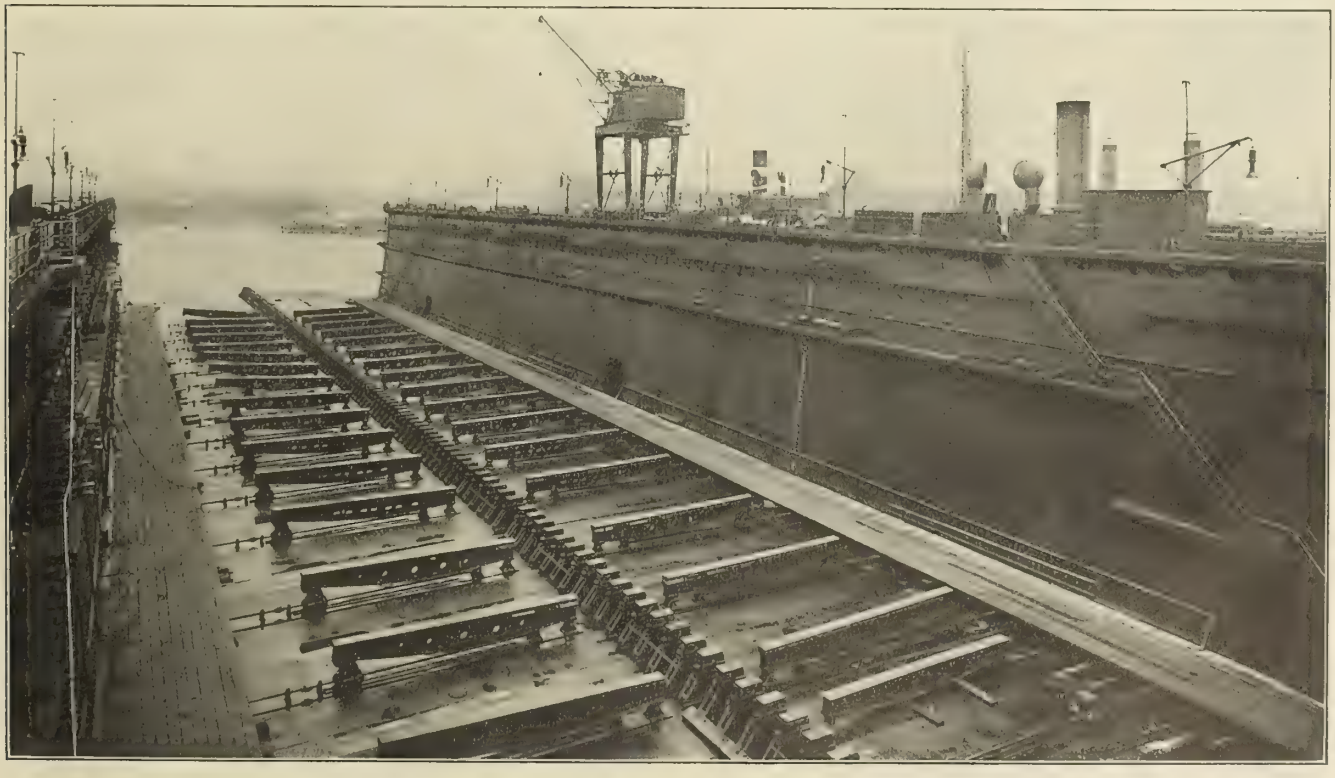


FIG. 2.—INTERIOR VIEW OF VULCAN DOCK, LOOKING AFT

French Battleship Jean Bart

The first French dreadnought, the *Jean Bart*, completed her official trials on May 15. This vessel was authorized by Parliament April 5, 1910; the order for her construction was placed with the Brest Dockyard Aug. 5, 1910; the keel was laid on Nov. 10, 1910, and she was launched in September, 1911. The main particulars are:

Length	541 feet 2 inches
Breadth	88 feet 8 inches
Draft, amidships	29 feet
Draft, astern	29 feet 7 inches
Brake horsepower	28,000
Speed	20 knots

The main armament consists of ten 12-inch guns located in five turrets. The elevation of the turrets above the load waterline is as follows: No. 1, 30 feet 7 inches; No. 2, 37 feet 1 inch; No. 3, 25 feet; No. 4, 28 feet 7 inches; No. 5, 21 feet 5 inches. The arc of fire available for each turret is as follows: Nos. 1 and 5, 135 degrees; Nos. 2 and 4, 140 degrees; No. 3, 180 degrees. The 12-inch guns are 59 feet long, weigh 55 tons each, and fire a shell weighing 970 pounds.

The secondary armament consists of twenty-two 5.5-inch guns; four 3-pounder guns and four 18-inch torpedo tubes, located two forward and two aft. Besides this armament the ship carries forty submarine mines of the Sauter-Harlé pattern.

The main armor belt extends for a length of 214 feet, and is 10 inches thick, reduced to 6.5 inches at the ends. The main belt is 13 feet 4 inches wide, and extends 7 feet 8 inches above the load waterline. The main citadel, which extends about 197 feet along the length of the vessel, is protected by 7-inch armor extending to a height of two decks, the ends of the citadel being inclosed with athwartship bulkheads of the same thickness. There are also two protective decks, the lower one, consisting of 2-inch plating on the flat and 3-inch plating on the slopes, extends 5 feet 7 inches below the load waterline. The upper protective deck is at the level of the upper edge of the main armor belt, and is made of 1 13/16-inch plating.

Steam is supplied by twenty-four watertube boilers of the Delaunay-Belleville type, having a total heating surface of 63,917 square feet and a total grate surface of 1,923 square feet. In these boilers the elements are made up of generating and reheating tubes. The generating tubes are 7 feet 11 inches long, 4 9/16 inches outside diameter, while the reheating tubes are 6 feet 7 inches long, 2¾ inches outside diameter. Each boiler has four furnaces, and they are arranged for using either coal or liquid fuel, the Delaunay-Belleville burner being used for liquid fuel.

There are thirteen coal bunkers having a total capacity of 2,700 tons and four compartments for liquid fuel, having a total capacity of 300 tons. Under ordinary circumstances only 900 tons of coal are to be carried. The steaming radius with full bunkers is 8,500 miles at 10 knots speed and 2,300 miles under full power.

Propulsion is by two sets of Parsons turbines, the starboard and port sets being entirely independent. High-pressure turbines drive the wing shafts and low-pressure turbines the inner shafts. The turbines are arranged in three independent engine rooms, the two high-pressure turbines being located each in a separate compartment, and the two low-pressure turbines in the center compartment. The condensers are also located in two independent compartments aft of the turbine rooms.

The first stages of both the ahead and astern high-pressure turbines are made up of wheels 11 feet 2 inches diameter, carrying four rows of buckets, while all other parts of the turbines, including the low-pressure turbine, are mounted on drums, and act on the reaction principle. The turbines have been designed for working at 300 revolutions per minute. Live steam may be delivered directly to the low-pressure turbines, and therefore the inner propellers may be set at work without interference with the wing propellers. The astern turbines have been designed for developing about 40 percent of the ahead power.

The condensers are of the usual type, with tubes 10 feet long and have a cooling surface of 16,038 square feet each.

The auxiliary machinery includes six electric generating sets of 200 kilowatts capacity operated by high-speed reciprocating engines.

OFFICIAL TRIALS

Ten-Hour Full-Speed Trial, April 29

Number of boilers at work	24
Steam pressure	256 pounds
Average revolutions per minute	285
Mean speed on measured mile	21.16 knots
Mean speed for the 10 hours	21.09 knots
Mean speed per contract	20 knots
Fuel consumption per mile (per contract)	2,646 pounds
Fuel consumption per mile on trial	2,449 pounds

Three-Hour Full-Speed Trial with Forced Draft, May 5

Number of boilers under steam	24
Steam pressure	256 pounds
Revolutions per minute	305
Brake horsepower	42,000
Mean speed for three hours	22.04 knots
Best run on measured mile	22.63 knots
Fuel consumption per square foot of grate for 20 knots (per contract)	33 pounds
Fuel consumption per square foot of grate on trial	30 pounds
Fuel consumption on trial for 22.04 knots	33.3 pounds
Fuel consumption per horsepower, contract	1.874 pounds
Fuel consumption per horsepower, trial	1.698 pounds
Fuel consumption per mile run	3,168 pounds

Twenty-Four-Hour Endurance Trial, May 9 and 10

Number of boilers under steam	24
Number of revolutions per minute	240
Mean speed	18.57 knots
Consumption per mile, contract	1,830 pounds
Consumption per mile on trial	1,611 pounds

Cruising Trial, May 15

Number of boilers under steam	24
Mean speed	12.81 knots
Consumption per mile, contract	1,080 pounds
Consumption on trial	937 pounds

Obituary

E. S. ALEXANDER, assistant to the general manager of the Newport News Shipbuilding & Dry Dock Company, died June 5 from an operation for appendicitis. Mr. Alexander represented the Newport News yard in Philadelphia.

CHARLES H. CRAMP, for many years head of the shipbuilding firm of William Cramp & Sons' Ship & Engine Building Company, Philadelphia, died after a long illness in Philadelphia on June 6 at the age of 83 years. Mr. Cramp was one of the foremost American naval architects in his day, and did more to develop and advance the art of shipbuilding in the United States than probably any other man. He was the eldest son of William Cramp, founder of the Cramp shipyard, and entered his father's business as an apprentice at the age of 17. He was admitted to the firm in 1859, and remained at the head of the company until 1902, when he retired on account of advanced age. Throughout his life Mr. Cramp was actively engaged in the construction of a great many coastwise, transatlantic and naval vessels, both for the United States and foreign countries.

12,000-Ton Floating Dry Dock at Seattle

The Seattle Construction & Dry Dock Company, of Seattle, Wash., built during the last year and put into commission at their plant about February 1 of the current year a 12,000-ton floating dry dock of the "Rennie" type, the pontoons being of timber and the walls of steel. The general dimensions of the dock are as follows:

Length on keel blocks, 468 feet (to be increased later to 600 feet); width, 110 feet; width between walls, 90 feet; height of walls above deck of pontoons, 35 feet. There are six pontoons with the draft over the sill of 30 feet. The lifting power of the dock is 12,000 tons.

The six pontoons are identical in size and construction. Each pontoon contains eighteen trusses on 4-foot centers; the trusses are formed of arch members on top and longitudinal timber on the bottom, these two are connected by tie-rods and by struts and blocking between members. The deck of the pontoons upon which the walls are fitted is open to the walls, giving free communication for water between the walls and pontoons.

The center line bulkhead of the pontoons upon which the keel blocks rest, and which takes the weight of the vessel, is built up of heavy timbers and is watertight. On each side of the center are three bulkheads, one under the inboard side of the tower and two under the bilge blocks.

The connection between the steel towers and pontoons is made by heavy straps, which are bolted to the sides of the towers and to heavy steel straps on the sides of the pontoons. The connection on the inboard side of the towers is made in the same way.

The framing of the steel towers is cross-braced and stiffened by diagonals. The plating varies in thickness, and the towers are divided into six watertight compartments by bulkheads. A watertight steel flat extends fore and aft 9 feet below the top of the towers, which serves as a machinery deck where all the pump and capstan motors are located.

Any pontoon may be detached and self-docked at any time, thus making every part of the whole structure accessible for painting and repairing.

The keel blocks are placed 4 feet between centers, and are built up of 12-inch by 12-inch timbers. The two bottom timbers are of tallowwood and tapered, so that they can be driven out and the blocking removed under the keel of a vessel while on the dock. The bilge blocks are built up of fir timbers, and are so arranged that they can be altered easily to suit the shape of different vessels. The bilge blocks are pulled into position and removed by steel wire ropes running to hand winches on top of the towers.

When a vessel is in the dock, bow and stern lines are passed to the capstans on the towers, and the vessel is placed in position so that the keel is on the center line of the keel blocks. This position is indicated by centering chains extending across from tower to tower at each end of the vessel and having a plumb bob suspended at the center link.

The pumping plant consists essentially of six 18-inch vertical, motor-driven centrifugal pumps, having a combined capacity sufficient to dock a 12,000-ton vessel in two hours. The pumps are of the Kingsford Foundry & Machine Works, Oswego, N. Y., make, and are of the vertical, submerged volute type, each having a capacity of at least 500,000 gallons of water per hour against a static head varying from 4½ inches to 18 feet 5 inches. Each pump is driven by a 60-horsepower, 490 revolutions per minute, three-phase, 60-cycle, 440-volt constant speed vertical type induction motor of Westinghouse manufacture. All of the pumps and the operating house from which the entire dock is controlled are situated on one side of the dock, the operating house being located at one end of the tower on the upper or running deck.

One pump is located in each pontoon near the bottom of the pontoon and is mounted on a cast iron pedestal. The suction splits into two 12-inch branches, each one of which is provided with a "quick-opening" gate valve. Each branch serves one of the two watertight compartments of the pontoon. The twelve 12-inch gate valves are mechanically controlled, through rods and countershafts, by hand levers arranged in the operating house.

The motors are located on the machinery flat in the tower,

NEW SEATTLE FLOATING DRY DOCK OF 12,000 TONS CAPACITY

each being arranged directly over its respective pump, to which it is connected by a vertical shaft. A flexible coupling is fitted above each pump, and for carrying the weight of shafting, etc., a suitable thrust washer and collar is provided in the pump. Each motor is independently controlled from the operating house by an oil-immersed auto starter with automatic overload and no voltage release attachments.

For lowering the dock, water is admitted through the pumps and 12-inch lines.

Trim Indicators

The athwartship trim of the dock can at once be read by a pendulum inclinometer fitted on the wall of the operating house.

For the fore and aft trim a horizontal pointer, fitted with a lever, is used, a graduated scale and adjustment being provided for one end.

The head of water in each compartment of the dock is recorded by an altitude gage located in the operators' house. From this gage a small pipe leads to a suitable place in the respective compartments and terminates in an inverted cup. A compressed air tank is provided, with a connection to each indicator pipe, so that all water can be forced out of the pipe, thus insuring an accurate reading of the head of water carried by the air pressure.

Capstans and Bollards

For warping ships into position in the dock, the running deck of each tower is provided with eight bollards and three capstans, the capstans being located one at each end of the tower and one in the center.

These capstans are each driven by a 25-horsepower, 440-volt, alternating-current, 720 revolutions per minute motor. The motors are located on the machinery deck below, each motor driving its capstan through gearing and a worm and wheel. The worm-wheel is fitted on the lower end of the vertical shaft, passing up through the running deck and fitted into the capstan at its upper end.

The capstans are of cast iron, and are designed so that they can be released from the vertical shaft for hand turning, six sockets being provided in each capstan. A cast iron base provided with groove and ball bearings carries the weight of capstan and shafting.

British Battle-Cruiser Tiger

The new British cruiser *Tiger* was laid down at the Clydebank shipyard early in 1912. The British Admiralty have, as usual, issued no particulars of the ship, but the broad features of the design which are given here may be taken as fairly accurate. The *Tiger* will be the largest, the fastest, the best protected and the most powerfully armed ship of the type in the world. With her great speed she could keep at such a distance as to render any attack upon her ineffective, while able still to do great destruction to the opponent. It is interesting to show in tabular form the progressive steps of the past seven years in battle cruisers for the British navy.

	Invincible.	*Lion.*	*Tiger.*
Date of Launch.	1907.	1910.	1913.
Length overall...	562 ft. 0 ins.	700 ft. 0 ins.	730 ft. 0 ins.
Length B. P.....	530 ft. 0 ins.	660 ft. 0 ins.	680 ft. 0 ins.
Breadth.....	78 ft. 0 ins.	86 ft. 6 ins.	90 ft. 6 ins.
Draft.....	26 ft. 0 ins.	27 ft. 6 ins.	28 ft. 6 ins.
Displacement.....	17,250 tons.	26,350 tons.	28,000 tons.
I. H. P.....	41,000	70,000	99,000
Speed.....	25 knots.	28 knots.	30 knots.
Armor belt.....	7 ins.	9 ins.	11 ins.
Main battery.....	8 12-in. guns.	8 13.5-in. guns.	8 14-in. guns.
Secondary battery.	16 4-in. guns.	20 4.7-in. guns.	24 6-in. guns.
Torpedo tubes....	5 18-in.	5 21-in.	5 21-in.

The propelling machinery is of the Parsons steam turbine type, arranged for four screws. The turbines are designed to give 99,000 horsepower, and are placed in two watertight compartments, so that in each engine room there is one high-pressure ahead, and one high-pressure astern turbine mounted separately on the outer shaft, and a low-pressure ahead and astern turbine within one casing on the inner shaft. Four steel plate condensers are placed aft, together with the centrifugal pumps and other auxiliaries. The whole of the machinery arrangements are such as to preserve the independence of the port and starboard sets of machinery and to allow either set to be worked when all parts of the other are disabled. There are two air pumps and two circulating pumps for each pair of main condensers.

There are forty-two watertube boilers of the Yarrow type, working at a pressure of 235 pounds per square inch, and arranged for forced draft with closed stokeholds, and they are placed in seven boiler rooms. The coal bunker capacity is about 4,000 tons, and provision is also made for carrying 1,000 tons of fuel oil.

The ship has four propeller shafts, with one three-bladed, solid cast bronze propeller on each. She has two rudders of the underwater balanced type, with two sets of screw steering gear worked by one steam steering engine. The steering gear and rudder heads are placed under the protective deck. The ship's stern has a graceful curve and is made of cast steel, and it has no ram.

It was in the *Invincible* class that the all-big-gun principle was first adopted. They mounted eight 12-inch guns in four turrets, one forward and one aft, while the two on the broadside amidships were placed diagonally in order that they might be used on either broadside. In the *Tiger* this arrangement of guns has been discontinued, and her turrets are all arranged on the center line of the ship. The two turrets forward of the bridge are placed at different levels, so that the four guns may fire ahead and on each broadside. The 'midship pair will also fire on either broadside. The astern turret is on the upper deck level, and the superstructure has a long embrasure to give this pair of guns a wide arc of training before the beam.

The guns of the main battery are the new 14-inch pattern. The guns of the secondary battery are 6-inch quick-firing, and these are placed in the superstructure. The torpedo tubes are all under water. Torpedo defense nets are fitted all fore and aft, and they are suspended from sixteen booms on each side of the ship.

There are two lifeboats hung in davits, and motor launches and other small boats are stowed above the superstructure.

The *Tiger* is a powerful looking ship, with three vertical smokestacks and one mast. She is provided with the usual wireless telegraphy arrangements. The side armor is in three strakes, and extends to within about 60 feet of the stem and about 70 feet of the stern. For a length amidships two of the strakes are 11 inches thick, and the top strake is 7 inches, all tapering to 4 inches thick at the forward and after ends. The turrets are also of 11-inch armor.

The designed speed of the vessel is 30 knots, which will doubtless be greatly exceeded on the full power trial.

Marine Developments in Russia.—A Russian Imperial Vice-Consul informs International Marine Engineering of great developments taking place in Russia, including the following of a marine nature: The Admiralty will spend five hundred million rubles on new war vessels, to be built largely, if not entirely, in Russian shipyards. Two hunded million rubles are for enlarging and equipping with freight-handling apparatus Russian seaports. As Russian shipyards are overwhelmed with work, orders will probably be placed abroad for six powerful ice breakers, a fleet of tugboats, large and powerful dredges and other craft. Undoubtedly full information regarding any of these undertakings can be secured from the Russian Ambassador.

Change of Address.—Robert S. Haight, consulting engineer, ship and engine surveyor, is now located at 17 State street, New York City.

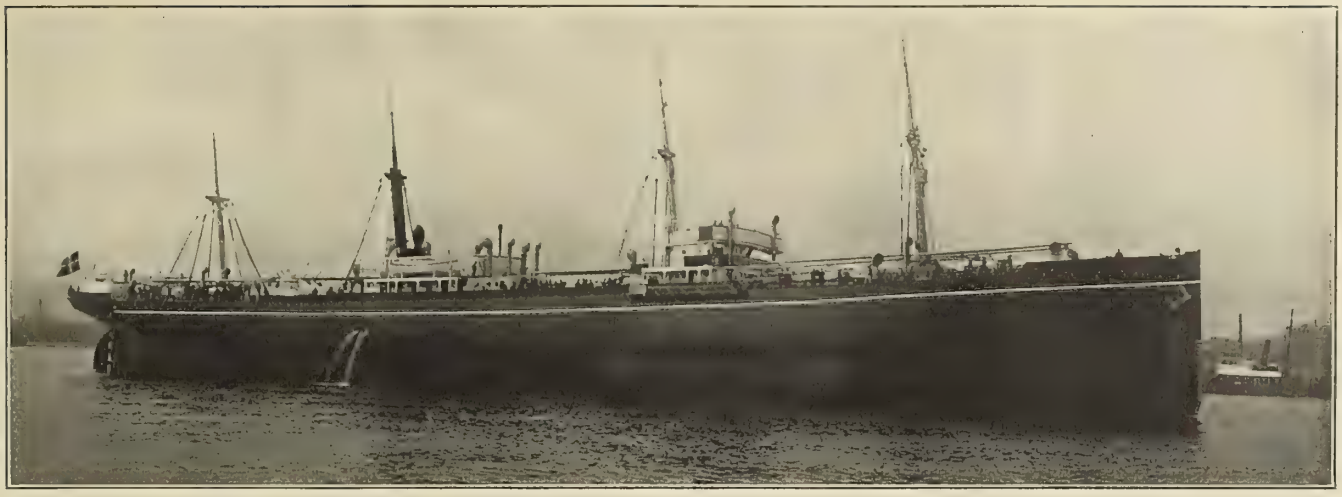


FIG. 1.—MOTOR SHIP SIAM, OF 13,200 TONS DISPLACEMENT

World's Two Largest Motor Ships

BY J. RENDELL WILSON

Until the Krupp 15,000-ton tank ship is launched the two new Burmeister & Wain motor ships *Siam* and *Annam* are the largest afloat, both being of 13,200 tons displacement. These ships are sister ships and conform to the main particulars published in the last issue. The general appearance of the ships and their engines is shown in the accompanying photographs.

The rapidity with which these builders are turning out these craft is truly remarkable when one considers the delay and postponed trials of certain other Diesel ships. As I write the new boat *Siam* has passed her trials successfully and is *en route* for Port Said, while by the time this appears in print her sister ship *Annam* will have commenced her maiden voyage. The latter makes the fifth large Diesel vessel that Burmeister & Wain have completed in under two years, the other three being the *Selandia, Christian X.* and *Suecia.* In addition they have eleven more on order, with an aggregate

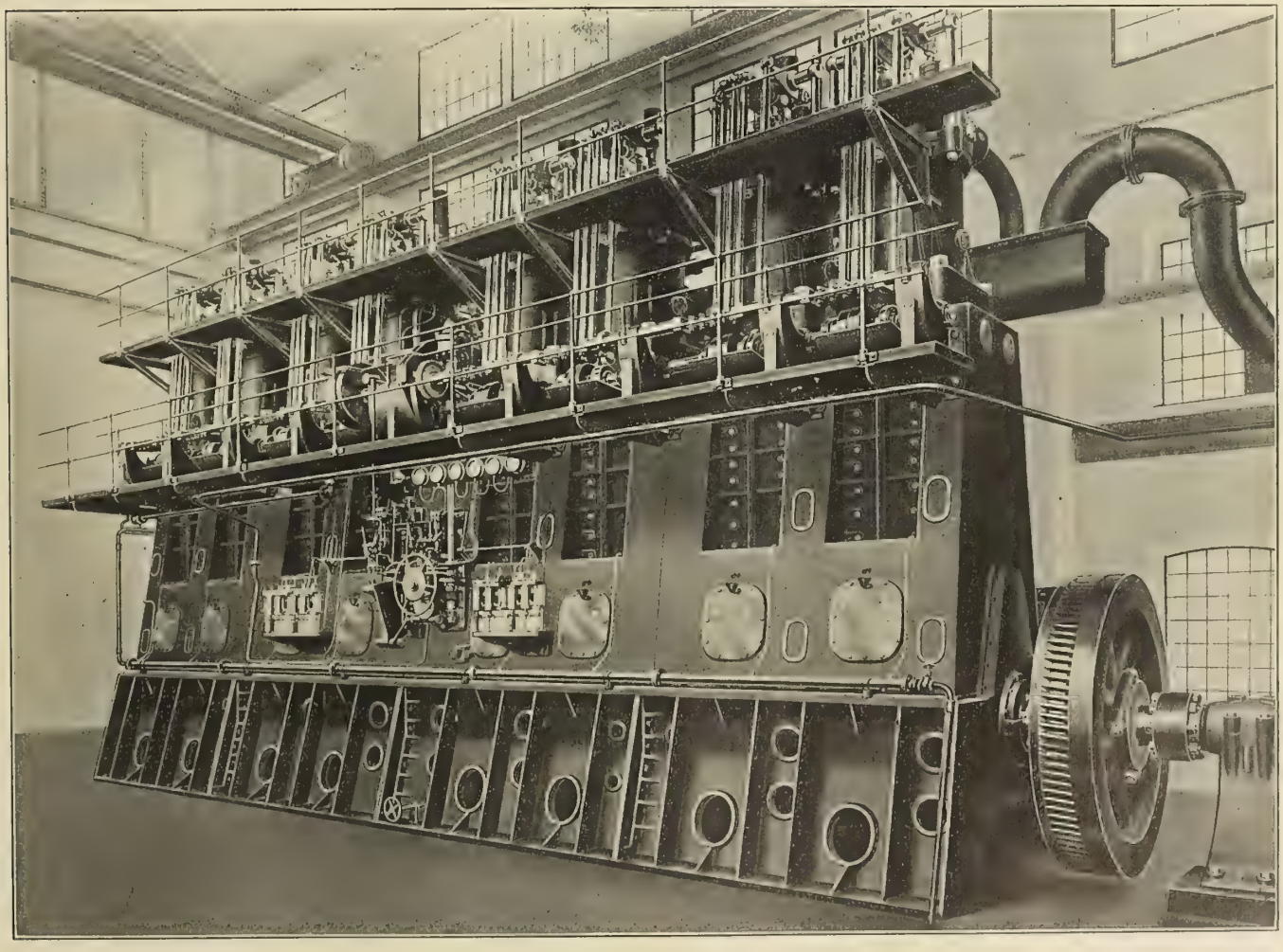


FIG. 2.—EIGHT-CYLINDER, BURMEISTER & WAIN DIESEL ENGINE FOR MOTOR SHIP SIAM

deadweight capacity of 83,500 tons and a horsepower of 30,700 indicated horsepower, one alone being of 4,000 indicated horsepower. It should be carefully noted that all these craft have or are having engines of the four-stroke type, which is a distinct shower bath for those who are firmly convinced that the two-stroke motor is the Diesel of the future, especially as the other four-stroke Diesel concerns, namely, the Werkspoor Company, the Kolommaer Company and Nobels can all show similar big order lists.

With regard to the other motor ships building by Burmeister & Wain, the complete list is as follows:

Vessel Yard No.	Owner	Length Feet	D. W. C. Tonnage	I. H. P.
286.	Nordsjjernan.....	362	6,650	2,000
289.	"	"	"	"
290.	"	"	"	"
297.	"	"	"	"
298.	"	"	"	"
291.	Fornede Dampskib Selskab.....	405	7,250	2,700
293.	East Asiatic Co....	395	6,700	4,000
294.	"	410	9,200	3,500
295.	"	"	"	"
299.	"	"	"	"
300.	"	"	"	"

All are cargo vessels excepting yard No. 293, which will also carry passengers. This ship will have a speed of 13½ knots. With the two boats just described, and the three earlier motor ships *Selandia, Christian X.* and *Suecia,* the grand total power is 44,200 indicated horsepower, and the deadweight capacity is 124,250 tons, which is sufficient to give a good indication of the present stage of the industry. In any event the confidence of ship owners in the Diesel engine is well expressed.

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation reports 189 vessels of 39,913 gross tons built in the United States and officially numbered during the month of May. Eight of these, aggregating 21,283 gross tons, were steel steamships, 60 percent being built on the Atlantic coast and 37 percent on the Great Lakes.

A New Mail and Passenger Steamship for Newfoundland

BY F. C. COLEMAN

The steamship *Kyle,* shown in Figs. 1 and 2, is one of two steamships recently built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of the Neptune Shipyard, Walker-on-Tyne, for the Reid Newfoundland Company. The steamship *Lintrose,* delivered in March last, is now used in giving a service between the Reid Newfoundland Railway Company's terminus at Port Basque and Sydney, Cape Breton. The *Kyle* is intended for the Reid Newfoundland Company's coastal service between St. Johns and Cape Chudleigh, on the coast of Labrador, a service occupying a fortnight for the round trip. As this service is to be maintained all the year round, the *Kyle* has been specially designed and built to run through the heaviest ice which is met with during the winter months, and she is, besides, a finely modeled vessel, able to maintain

FIG. 1.—STEAMSHIP KYLE

a comparatively high rate of speed. Her accommodation for carrying passengers is of the most up-to-date and comfortable description, and well lighted, heated and ventilated.

The dimensions of the vessel are 220 feet length, 32 feet beam. Accommodations are provided for 68 first class and 141 second class passengers. The first class passengers are berthed amidships. They have a fine promenade deck, and in the house on that deck there is a comfortable smoking room, the walls being of oak, slightly fumed, with corresponding furniture upholstered in green leather. In the same house are the captain's room, the chief officer's room and the wheelhouse. Below this, on the upper deck, are the ladies' room and the first class dining saloon. The ladies' room has walls of sycamore, satinwood furniture upholstered in old rose moquette. Aft of the ladies' room is the entrance to the first class dining room. The dining saloon is a fine apartment, with walls and furniture of polished mahogany, the latter being upholstered with blue leather. This room is divided from the entrance by a very effective screen of polished mahogany, filled in with stained glass. The entrance hall and staircase connect the smoking room, dining saloon and first class staterooms, etc., and they are paneled in polished mahogany, while the floor is of india rubber tiling. The first class staterooms, situated on

the main deck below the dining saloon, are fifteen in number, with accommodations for sixty-eight persons, one room being a ladies' room having ten berths. These are all enameled white, with mahogany furniture and upholstered with rose-colored moquette. The second class passengers are berthed in the after part of the vessel. On the main deck there is a compartment for 102 men, and aft of this another for 39 women. Above, on the upper deck, right aft, are two hospitals, one for men, the other for women, together with rooms for doctors, baths, etc. The officers and engineers have rooms on the main deck at the sides of the engine casing, and the galley is placed on the upper deck forward of the engine casing, conveniently near the dining saloon.

The steamer is fitted with an installation of wireless telegraphy, a complete installation of electric light, including a searchlight, and an arrangement for steam heating suitable for the climate.

The vessel is propelled by a set of single-screw triple-expansion engines, having cylinders 18½ inches, 30½ inches and 50 inches diameter, by 36 inches stroke, supplied by steam from two single-ended boilers, 13 feet 9 inches diameter by 11 feet 6 inches in length, fitted with six corrugated furnaces, and working under Howden's system of forced draft at a pressure of 180 pounds per square inch. The main condenser is one of Weir's latest uniflux type.

Included among the auxiliary machinery in the engine room are Brown's steam and hydraulic reversing engines, a pair of Weir's feed pumps with direct contact feed heater, a centrifugal circulating pump, a feed-water filter, auxiliary condenser, two Alley & MacLellan's steam ash hoists, a MacNab indicator fitted on the bridge to indicate the movement of the main engines, and Brundrits circulators to the boilers, etc.

On the trial trip, which took place recently off Tynemouth, a speed of 13¾ knots was attained.

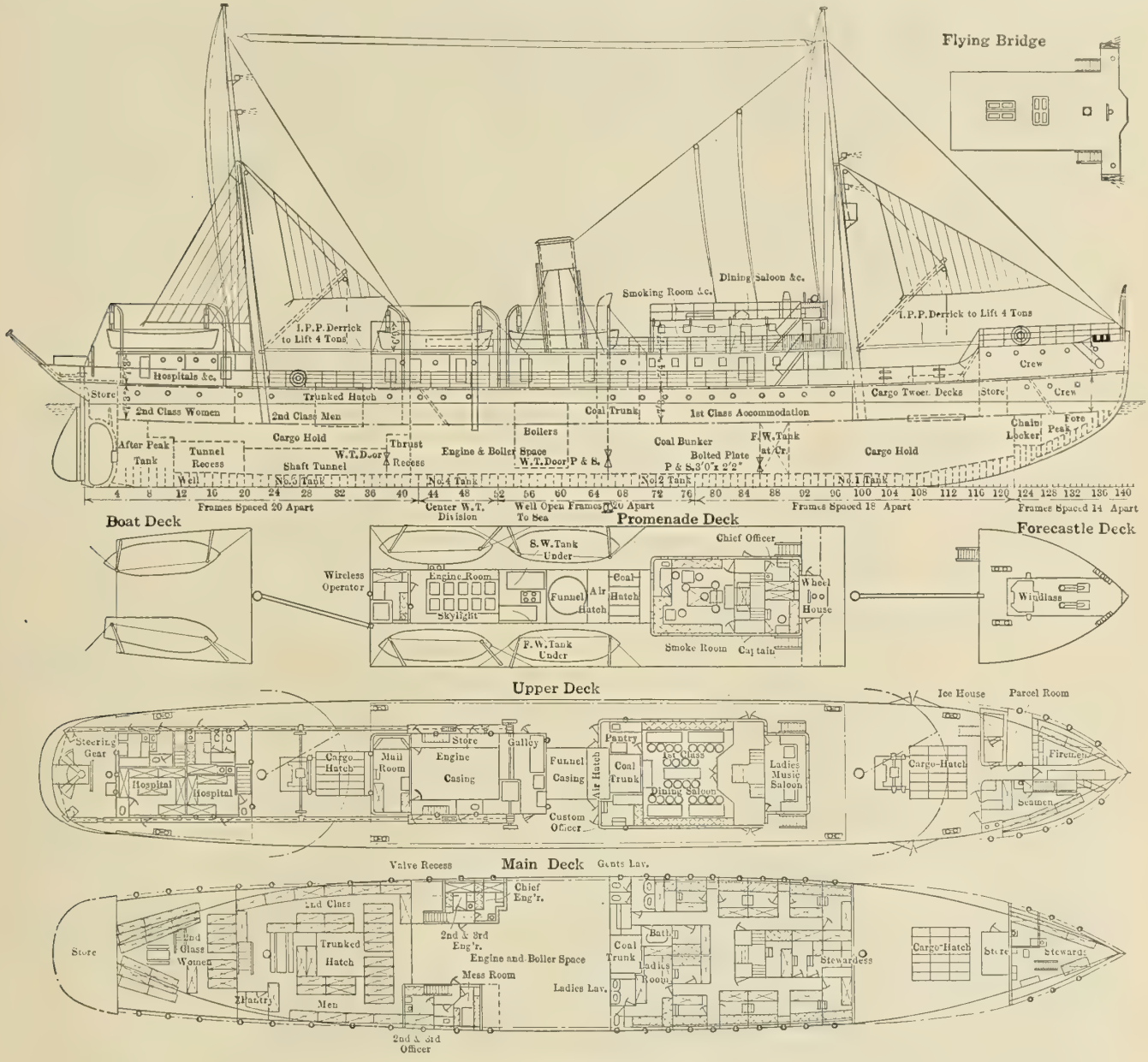


FIG. 2.—GENERAL ARRANGEMENT OF STEAMSHIP KYLE

SPEED OF THE ARKANSAS.—On her standardization trials off Rockland, Me., May 31, the United States battleship *Arkansas*, constructed by the New York Shipbuilding Company, Camden, N. J., exceeded by nearly a knot the speed she made on her builders' acceptance trials. The fastest run on the Rockland course, May 31, was at a speed of 22.345 knots, while the fastest run on the builders' acceptance trials was at the rate of only 21.5 knots. The speed of the sister ship, *Wyoming*, on her acceptance trials was 21.223 knots.

Equipment for Unloading a Special Cargo at a German Steamship Pier

In a series of articles published in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* by Prof. M. Buhle, of Dresden, dealing with new pneumatic suction grain elevators and other conveying and storage plants built by G. Luther, A. G., in Braunschweig, a description is given of an interesting equipment for unloading and conveying cargoes of nitrate of soda from steamships to specially designed storage houses. Nitrate of soda is brought to Germany from June to September, and must be stored until the following spring. In the place where this equipment was installed it was necessary to cross an arm of the river 200 feet wide to obtain storage space that would accommodate as much as 25,000 tons. The storehouse was constructed of reinforced concrete with four bays, each 200 feet long and 63 feet wide, in which the nitrate of soda is stored to a height of from 16 to 27 feet.

To unload the nitrate of soda, revolving dock cranes were used, delivering the cargo to the conveying plant. As the material could be handled only in bags, a conveyor line, extending the length of the pier back to the buildings and throughout the entire length of each shed, seemed best to fulfill the requirements. The electrically-driven trolleys are suspended from overhead tracks, carrying two platforms for bags and one operator's cage. It was thought best to have an operator on each trolley, as then its speed could be much higher, requiring fewer trolleys, giving greater safety of opera-

FIG. 1.—SECTION OF PIER AND STOREHOUSES THROUGH B, FIG. 2

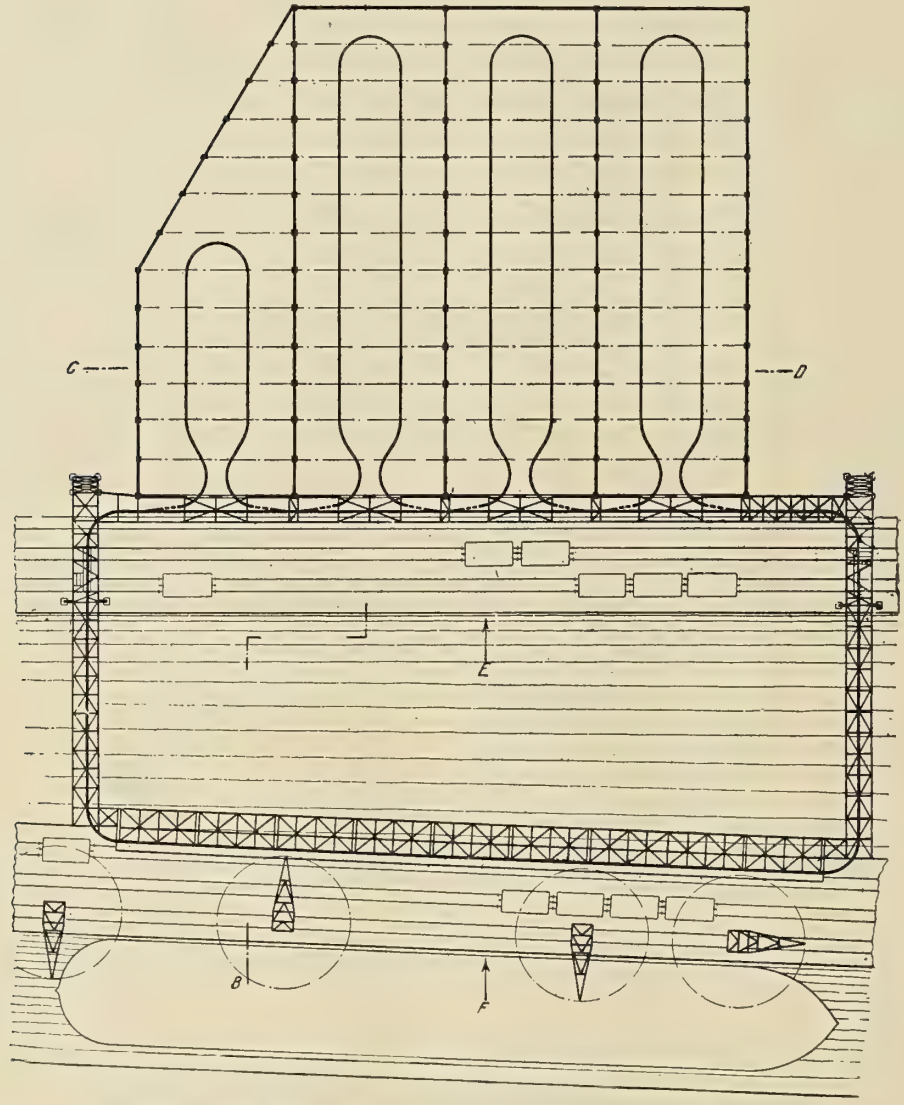


FIG. 2.—PLAN OF PIER AND STOREHOUSES, SHOWING ARRANGEMENT OF CONVEYORS

tion and placing the material in the sheds much more readily.

To realize the full capacity of 600 bags per hour, the lifting motor and gear is in duplicate, thereby handling at each time two platforms with their loads. On board ship eleven bags are placed on one platform, which is lifted by the revolving dock cranes to an intermediate platform, where the trolleys take hold of two of them. In front of each shed are switches to direct the trolleys into any one bay. Before entering the sheds the bags are weighed on two automatic scales built directly into the trolley structure. At present two trolleys are in operation, which handle about 600 bags, or 60 tons per hour.

The motors are supplied with direct current of 200 volts, which is carried to them by a copper wire underneath the main supporting I-beam track. The trolleys are so constructed that a curvature of 13 feet 4 inches can be traversed without shock at a speed of 600 feet per minute. The winches on the trolleys are of the usual type, suited to overhead support with double drums, worm and wheel and single gearing drive. Each winch has its own motor. The switches of the track are hand-operated turntables, with special electrical block signals for indicating danger in case of an open switch.

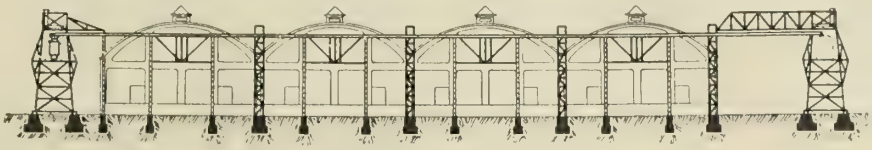


FIG. 3.—SECTION THROUGH E, FIG. 2

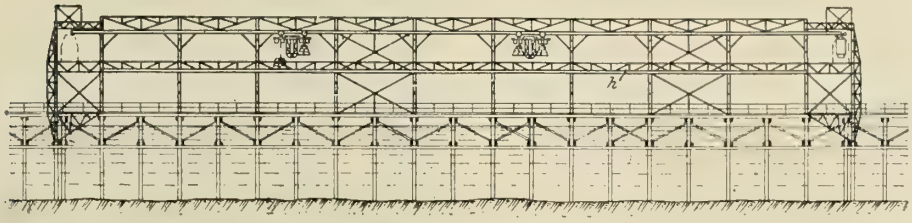


FIG. 4.—SECTION THROUGH F, FIG. 2

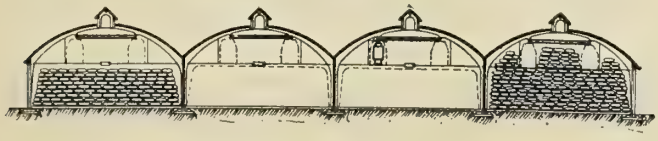


FIG. 5.—SECTION THROUGH C, D, FIG. 2

Motor Ship Fordonian

The Diesel-engined motor ship *Fordonian*, built by the Clyde Shipbuilding & Engineering Company, and fitted with a Carels Diesel engine, rated at 750 to 900 horsepower, recently made a trip from Port Glasgow to Sydney, a distance of 2,300 miles, in 17 days 21 hours. Very heavy seas were encountered on this voyage, but no difficulty was experienced with the machinery and no stops en route were necessary. The engine averaged 800 indicated horsepower on this trip, and the daily fuel consumption was 3½ tons.

Part of the ship's cargo was unloaded at Sydney and the rest at Montreal, where another cargo was shipped for Toronto, from which port the vessel will now enter upon regular service between Toronto, Kingston, Cleveland, Detroit, Port Arthur and the Western Lake shipping points. The *Fordonian* is owned by the Merchants' Mutual Line, and is under the direct supervision of Mr. Duguid, general superintendent of the line.

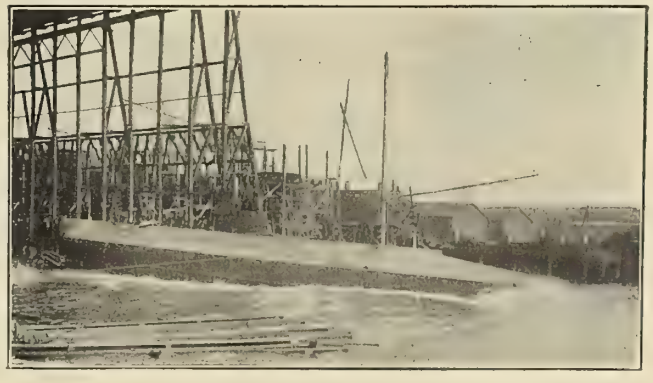
The vessel itself is 250 feet long, 42 feet 6 inches beam, 16 feet 10 inches molded depth to the main deck and 26 feet 6 inches to the awning deck. The deadweight carrying capacity is 3,300 tons on a draft of 16 feet 6 inches. As the draft in service will be restricted to 14 feet, the deadweight carrying capacity will be reduced to 2,200 tons.

The main propelling engine is a four-cylinder, two-stroke cycle, single-acting Carels engine with cylinders 18.1 inches diameter by 32.25 inches stroke. The propeller is 11 feet 9 inches diameter by 9 feet pitch.

Launch of Chilian Submarine

An event significant to this and South American nations, and particularly to the Pacific Coast, since it marks an epoch in the building of foreign warships on that coast, was the formal launching, under auspicious circumstances, of the Chilian submarine *Iquique* at the plant of the Seattle Construction & Dry Dock Company, Seattle, Wash., on June 3.

The *Iquique* was christened by Senora Maria Lorrain de von Schroeders, wife of Lieut. Edgar de von Schroeders, who is to be the first commander of this under-water fighter.



LAUNCH OF CHILIAN SUBMARINE AT SEATTLE

The vessel was built under the supervision of the Electric Boat Company, of which T. S. Bailey is Pacific Coast manager and G. H. Eggleton constructing engineer. A sister submarine for the Chilian Government, the *Antofagasta*, which is now building at the Seattle plant, will be launched in August. Both vessels will be delivered to the Chilian Government at Valparaiso, to which port she will be towed from Seattle under the direction of the Electric Boat Company. The crew for the *Iquique* was in Seattle at the time of the launching and was instructed in her operation during the builder's trial trips.

French Destroyer Magon

The destroyer *Magon* was launched on April 19 at the yards of the Ateliers & Chantiers de Bretagne, Nantes, France. This vessel belongs to the new class of 800-ton destroyers which have been specially designed as "fleet destroyers." The design of the hull was worked out by the technical staff at the shipyard with the assistance of Mr. Laubaeuf, the well-known naval architect, and shows a bold departure from the former types of destroyers. The stern of the boat, as shown by the photographs, is practically that of a racing motor boat. The design was worked out with the special intention of making the vessel capable of keeping up her speed in any kind of weather without undue stress.

The main particulars of the vessel are: Length over all, 272 feet 4 inches; beam, 27 feet; depth, 16 feet 5 inches; draft at stern, 10 feet; trial displacement, 787 tons; displacement with extra bunkers, 850 tons. The hull is built of Siemens-Martins steel, and is divided into eleven watertight compartments. The stem is of forged steel, and the stern post and shaft brackets, as well as the rudder, are all of cast steel. On each side of the center keelson there are five longitudinal girders or side keelsons. The sub-division of the boat is practically the same as in the *Fourche* and *Faulx*, described in previous issues of this journal; that is, the first compartment is the collision compartment, then come the chain lockers, stores and crew's quarters; aft of which are two independent boiler rooms, then two independent engine rooms, and finally the officers' and petty officers' quarters, ammunition rooms and storerooms.

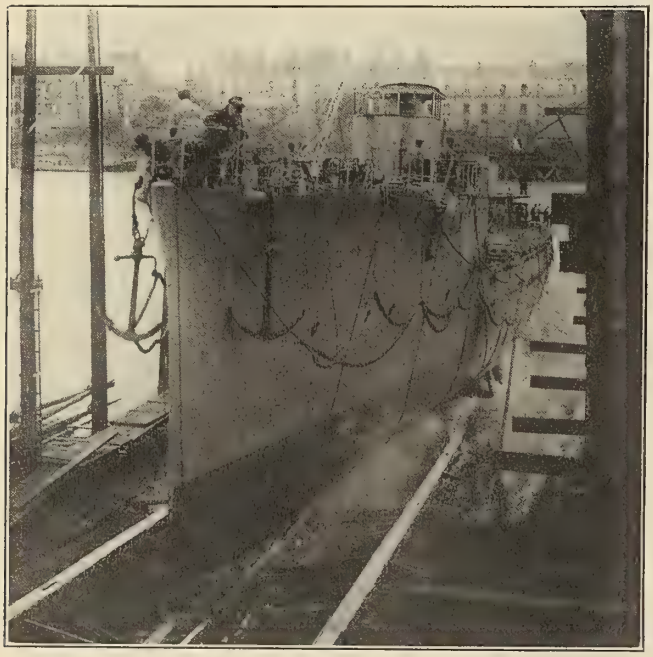


FIG. 1.—LAUNCH OF THE MAGON

Steam is supplied by four watertube boilers of the du Temple type at a pressure of 228 pounds per square inch. The boilers are fired with liquid fuel through du Temple burners, the maximum pressure of air in the stokehold not exceeding 6½ inches of water. The liquid fuel tanks have a total capacity of 1,300 cubic feet.

The main propelling machinery comprises four Rateau-Chantiers de Bretagne turbines (two for ahead and two for astern working), driving two bronze propellers, 7 feet 2 inches diameter and 7 feet 5 inches pitch. The turbines are arranged in two sets with two turbines in a single casing. Each set of turbines, comprising one ahead and one astern turbine, is therefore an independent set. The steam pressure at the entrance nozzles is 200 pounds per square inch, and at 650 revolutions per minute the designed brake-horsepower is 18,000, calculated to give the vessel a speed of 30 knots, although it is confidently expected that the contract speed will be considerably exceeded, giving a performance of something like 34 knots. Steam is exhausted from the turbines into two independent condensers, each of which has a cooling surface of 5,490 square feet.

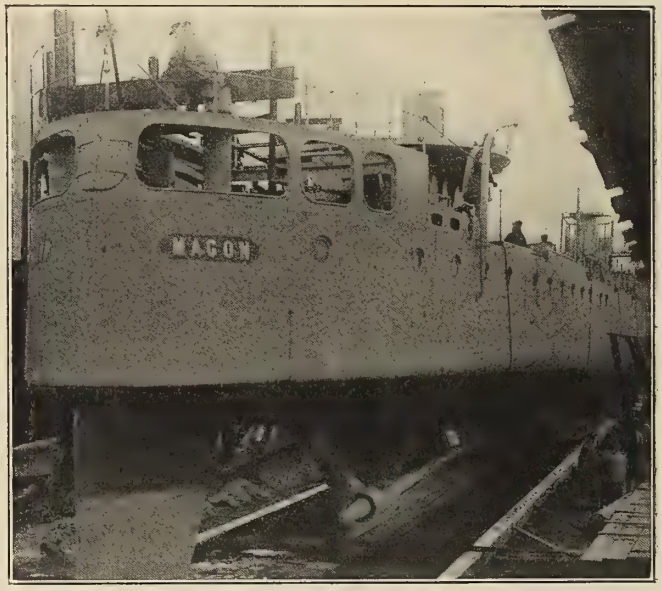


FIG. 2.—STERN OF MAGON

The electric plant on this boat consists of two dynamos of 13 kilowatts and 80 volts, operated by kerosene (paraffin) motors. The pumping arrangement consists of two powerful steam pumps, having a total capacity of 40 tons per hour.

The armament consists of four 65-millimeter quick-firing guns at the sides and two 4-inch guns fore-and-aft, besides four 18-inch torpedo tubes.

A New Type of Submarine Boat

The L. A. Submarine Boat Company, Long Beach, Cal., has recently completed for experimental and demonstration purposes a submarine boat built after designs patented by John M. Cage, general manager of the company. This test boat is 75 feet long, 7½ feet beam, with a depth of 9½ feet from the bottom of the keel to the top of its superstructure. The propelling machinery consists of two 90-horsepower Buffalo gasoline (petrol) engines, turning 900 revolutions per minute at full speed. The boat is also equipped with an air compressor and flasks for storing up 36,000 cubic feet of air at a pressure of 3,000 pounds.

This type of submarine differs from present types in three particulars. First, the gasoline (petrol) engines are used for motive power both while running on the surface and while running submerged. The expulsion of exhaust gases from the engines while running submerged is accomplished by mechanical means, thus giving the same amount of power available for propulsion under water as upon the surface and doing away with the electric storage battery system used in other types. Having the same power available for submerged running, it is claimed that a greater speed can be obtained while the boat is submerged than while on the surface, due to the absence of wave-making resistance while running submerged. Second, the propellers are placed at the forward end of the boat instead of at the stern. This principle, it is claimed, gives greater rudder control, in that it makes the point of application of the propelling force the fulcrum about which the ship is swung when taking a new course. Inci-

FIG. 1.—CAGE SUBMARINE BUILT FOR EXPERIMENTAL PURPOSES

dentally it enables the design of a boat with more reference to speed lines allowing a heavy fore body with full entrance and a light, fine after body with long run and broad horizontal rudders. The application of power in this boat, and the consequent control, it is claimed, overcomes the inherent tendency in the present type of submarine to "root" at a critical speed above which it is not safe for them to run even if they were powerful enough to do so. Third, by means of two tanks, one forward and one aft, which are open at the bottom to the sea and normally kept full of water, this submarine at all times has a large percentage of reserve buoyancy, as the normal displacement of the boat can be increased by blowing out the water from these tanks, effecting the same results as is often acquired by heavy drop keels. For submerging and trimming small ballast tanks are used.

Besides these three basic principles the builders of the boat claim to have accomplished considerable improvements in automatic equipment for trimming, depth control, ventilating, etc.

The experimental boat illustrated was given a thorough test in Long Beach harbor on March 26. The boat was submerged in 30 feet of water with the engines exhausting overboard against a back pressure of 12½ pounds, at the same time maintaining a vacuum on the engine exhaust of 23½ inches. The engines have also been run under water with a valve on the outboard exhaust closed down until the gage showed a back pressure of 150 pounds, corresponding to a depth of water of over 300 feet. At this pressure it is said the engines will run for thirty minutes, exhausting into a vacuum of 6 inches.

FIG. 2.—ENGINE ROOM OF CAGE SUBMARINE

Running on the surface a speed of 15 knots was obtained, and although the limits of the harbor where the tests were made prevented speed tests while submerged, yet it is estimated that when tried out in the open sea a speed of 19 knots can be obtained on the surface and about 19 1/3 knots submerged. Sufficient compressed air is carried on the boat to run the engines full speed submerged for four hours.

During the tests above referred to the boat was submerged for a depth of 18 feet under water, and it was demonstrated that the boat could be submerged either in a horizontal position or in an inclined position, either bow or stern first.

The Deflection Method of Calculating the Strength of Columns and Stanchions—I

A Fundamental Misconception in the Moncrief Formula, which has been Accepted as the Basis of the United States Navy Instructions for Determining the Scantling of Ship Columns

BY A. J. MURRAY

A free ended column supporting a load which rests exactly over its axis would not theoretically deflect, except upon the application of some lateral force. The condition would, however, be one of unstable equilibrium. The slightest disturbance would upset this state of unstable equilibrium, and the column deflect under the load.

The "deflection," or "eccentricity method," consists in assuming an eccentricity of loading, so that the column deflects initially by an amount depending upon the applied load, the

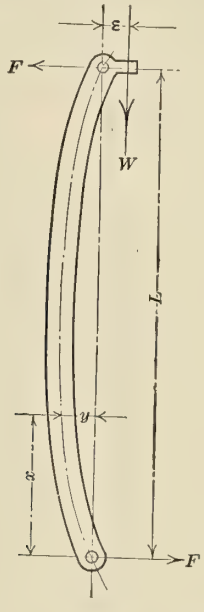


FIG. 1

eccentricity, and the material and proportions of the column. We might have regarded the eccentricity as due to a want of straightness in the column itself, but that would necessitate making an assumption as to the exact form of the supposedly bent column. Instead of this we have taken the column to be initially straight and the supports central, but supposed the load not placed exactly over the axis.

In Fig. 1 is shown diagrammatically a column loaded at a distance ϵ from the axis. The ends are guided in a vertical direction by means of frictionless pins, and the eccentricity ϵ is measured in the plane of bending, which is normal to the axis of the pins.

The Moncrief formula is based upon three assumptions:

(1) That the reactions of the pins at the top and bottom of the column may be neglected.

(2) That the form of the deflection curve is parabolic.

(3) That the neutral axis of any cross section passes through the center of gravity of that section.

The first of these assumptions we can regard only as a serious misconception, which invalidates any formulæ based thereon, as unless the load was applied through the pins, and these were not only eccentric, but by a miracle of chance lay in the same vertical line, there would be lateral reactions at the pins.

Let W = load on column.

L = length of column.

Since the column must be in equilibrium under the external forces coming upon it, there must be reactions at the top and

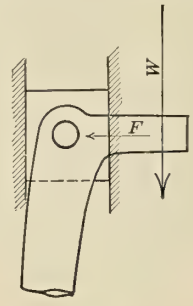


FIG. 2

bottom pins (Fig. 2), constituting a moment equal to the upsetting moment $W \times \epsilon$. Since there are no other horizontal forces these reactions must be equal and opposite.

Let T equal the magnitude of either reaction then for equilibrium

$$T \times L = W \times \epsilon$$

or

$$T = \frac{W\epsilon}{L} \qquad (1)$$

Now consider any section distant x from the foot of the column, and suppose the deflection from the vertical at that section is y. The bending moment at the section is then given by (Fig. 1)

$$M_x = W\ (\epsilon + y) - T\ (L - x).$$

Substituting T,

$$M_x = W\ (\epsilon + y) - \frac{W\epsilon}{L}\ (L - x).$$

$$= W\,y + \frac{W\epsilon x}{L}.$$

The Moncrief formula overlooks this reaction entirely, and therefore expresses the bending moment at the section x, thus:

$$M_x = W\ (\epsilon + y).$$

Diagrammatically, the curves of bending moment would for the two cases be as shown in Fig. 3.

To dwell upon the two remaining assumptions is like raising an outcry because a dead man is minus a leg, but as they help to illustrate the subject we shall note them briefly.

The assumption that the curve of deflection is a parabola was arrived at by interpolating between the Sine curve derived by Euler for ideal columns and the circular form which fits the case of a constant bending moment throughout the length. This assumption involves an error of some 10 percent for normal ship columns. The Moncrief formula assumes that

$$M_x = W\ (\epsilon + y),$$

which may be written

$$-E\,T\,\frac{d^2\,y}{d\,x^2} = W\,y + W\,\epsilon$$

a differential equation, of which the solution is

$$Y = A \text{ Cos. } nx + B \text{ Sine } nx - \epsilon,$$

where A and B are constants of integration, and

$$n = \sqrt{\frac{W}{E\,I}}.$$

From the terminal condition we have

$$A = \epsilon\, B = \frac{\epsilon\,(1 - \text{Cos. } n\,L)}{\text{Sin. } n\,L},$$

or

$$y = \epsilon \text{ Cos. } nx + \frac{\epsilon\,(1 - \text{Cos. } n\,L)}{\text{Sin. } n\,L} \text{ Sin. } nx - \epsilon$$

$$= \epsilon \left(\text{Cos. } nx + \frac{1 - \text{Cos. } n\,L}{\text{Sin. } n\,L} \text{ Sin } nx - 1 \right)$$

The parabolic method would have given

$$Y = \frac{W\,L^2\,\epsilon}{8\,E\,I - 5/6\,W\,L^2} \left(\frac{L^2 - 4\,x^2}{L^2} \right) + \epsilon$$

The third assumption turns out to be justifiable, though I find no reference to it either by Moncrief or by Mr. Anderson in his able explanation of Moncrief's deductions.

Moncrief assumed that the curve of deflection was parabolic, and given by

$$Y = \frac{\Delta\,(L^2 - 4\,x^2)}{L^2} + \epsilon$$

when Δ is the deflection at the middle of length. His bending equation we saw was

$$M_x = W\,y + W\,\epsilon$$

or substitute for Y

$$M_x = -E\,T\,\frac{d^2\,y}{d\,x^2} = \frac{W\,\Delta\,(L^2 - 4\,x^2)}{L^2} + W\,\epsilon.$$

Integrating out we get

$$\Delta = \frac{W\,L^2\,\epsilon}{8\,E\,I - 5/6\,W\,L^2}.$$

If p = direct compression stress, then the maximum fiber stress is on the compression side and at the middle section, and is given by

$$f = p + \text{bending stress.}$$

$$= p + \frac{y}{I}\,W \left(\epsilon + \frac{W\,L^2\,\epsilon}{8\,E\,I - 5/6\,W\,L^2} \right)$$

giving Moncrief's formula:

$$\frac{L}{\gamma} = \sqrt{\frac{48\,E\left(\frac{f-p}{p} - \frac{y\epsilon}{\gamma^2}\right)}{5\,(f-p) + p\,\frac{y\epsilon}{\gamma^2}}}$$

Now, however, as we have both bending and direct stress at any section of the column, the neutral axis is not central, but at a distance h from the center, where $h = \frac{\gamma^2}{y}$ (γ being the radius of gyration of section), and the true bending equations are

$$\frac{f}{y + h} = \frac{E}{p + h} = \frac{M}{I},$$

so that

$$p = \frac{E\,I}{M_x} - \frac{\gamma^2}{y}.$$

For the parabolic curve assumed by Moncrief we should then have

$$\frac{d^2\,y}{dx^2} = \frac{1}{\rho} = \frac{W}{E\,I - W\,\gamma^2}\,(\Delta + \epsilon) - \frac{W}{E\,I - W\,\gamma^2}\,\frac{4\,\Delta}{L^2}\,x^2,$$

and integrating out we have

$$\Delta = \frac{\epsilon}{8\,\frac{\gamma^2}{L^2}\left(\frac{E}{p} - 1\right) - \frac{5}{6}},$$

instead of

$$\Delta = \frac{\epsilon}{8\,\frac{\gamma^2}{L^2}\,\frac{E}{p} - \frac{5}{6}},$$

as taken by Moncrief.

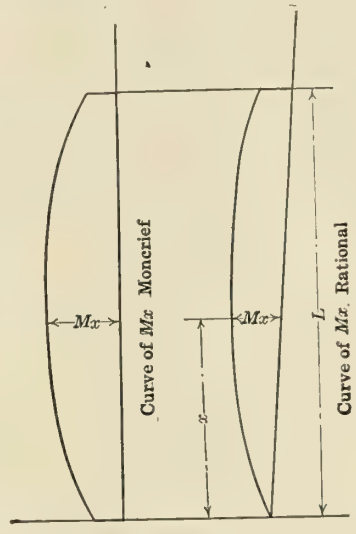


FIG. 3

Making this correction for the deflection, we get as a modified form of Moncrief's formula,*

$$\frac{L}{\gamma} = \sqrt{\frac{48\,(E-p)\left(\frac{f-p}{p} - \frac{y\epsilon}{\gamma^2}\right)}{5\,(f-p) + p\,\frac{\epsilon y}{\gamma^2}}}$$

the only difference being that E is replaced by $E - p$, which, as E is relatively large, makes practically no difference.

Finally, Moncrief claims that his formula agrees with experiment, and that the eccentricity factor $\frac{y\,\epsilon}{\gamma^2}$ may be regarded as a constant quantity.

Before leaving the subject of Moncrief's formula, it may be well to say that no censure of Mr. Anderson is intended, and that in telling us in the pages of this magazine just how he constructed the tables Mr. Anderson acted in the right spirit. In like spirit it is hoped he will accept and perhaps answer the above criticism.

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* This method of making a correction for the shift of the neutral axis was given by Nevill, who applied it to Euler's expression, and we have only applied his analysis to the case in hand.

A Rational Formula for the Strength of Round-Ended Columns

We have shown that the true bending equation for an eccentrically loaded column is

$$M_x = W\,y + \frac{W\,\epsilon\,x}{L}. \qquad (1)$$

For small deflections we have

$$-E\,I\,\frac{d^2y}{dx^2} = M_x = W\,y + \frac{W\,\epsilon\,x}{L}. \qquad (2)$$

The general solution of this equation is

$$y = A\ \text{Cos.}\ nx + B\ \text{Sin.}\ nx - \frac{\epsilon\,x}{L} \qquad (3)$$

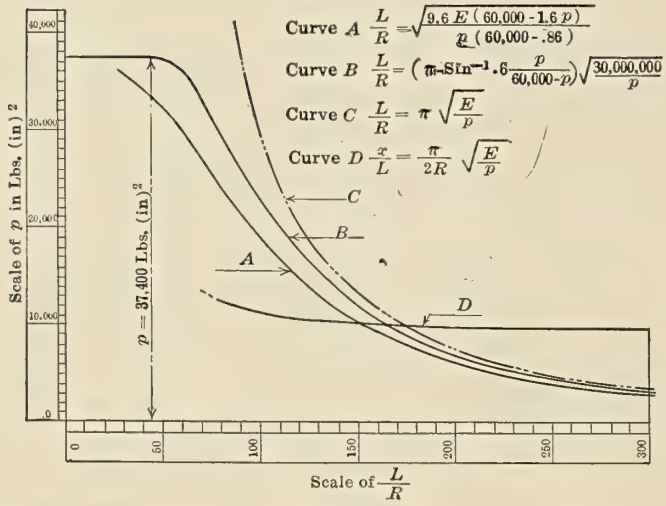
Curve A $\frac{L}{R} = \sqrt{\frac{9.6\,E\,(60{,}000 - 1.6\,p)}{p\,(60{,}000 - .86\,p)}}$
Curve B $\frac{L}{R} = \left(\pi - \text{Sin}^{-1}.6\frac{p}{60{,}000 - p}\right)\sqrt{\frac{30{,}000{,}000}{p}}$
Curve C $\frac{L}{R} = \pi\sqrt{\frac{E}{p}}$
Curve D $\frac{x}{L} = \frac{\pi}{2R}\sqrt{\frac{E}{p}}$
Scale of p in Lbs. (in.)^2
p = 37,400 Lbs. (in.)^2
Scale of $\frac{L}{R}$

FIG. 4—Curve *A*, plotted from Moncrief formula; curve *B*, plotted from rational formula; curve *C*, plotted from Euler formula; curve *D*, height above foot to the most stressed section in terms of the length of column.

$$\text{where } n = \sqrt{\frac{W}{E\,I}}.$$

To find the value of the constants A and B we have

when $x = 0$, $y = 0$, Cos. $nx = 1$.

$\therefore A = 0$.

Again, when $x = L$, $y = 0$.

$\therefore 0 = B$, Sin. $n\,L - \epsilon$,

$$\text{or } B = \frac{\epsilon}{\text{Sin.}\ n\,L}.$$

$$\text{Hence } y = \frac{\epsilon}{\text{Sin.}\ n\,L}\ \text{Sin.}\ nx - \frac{\epsilon\,x}{L}. \qquad (4)$$

Substituting this value of y in the bending equation (1) we obtain

$$M_x = W\,\epsilon\left(\frac{\text{Sin.}\ nx}{\text{Sin.}\ n\,L}\right) \qquad (5)$$

The only variable term is Sin. nx, and as the maximum value of Sin. nx is 1, we have

$$\text{Maximum bending moment} = \frac{W\,\epsilon}{\text{Sin.}\ n\,L}.$$

Taking the compression stress due to the direct load

$$= \frac{W}{\text{area of metal}} = p,$$

we have for the maximum fiber stress

$f = p$ + maximum bending stress.

$$= p + \frac{y}{I}\,\frac{W\,\epsilon}{\text{Sin.}\ n\,L}.$$

$$= p + \frac{\epsilon\,y}{\gamma^2}\,\frac{p}{\text{Sin.}\ n\,L}.$$

where γ = radius of gyration of the section. Therefore,

$$\text{Sin.}\ n\,L = \frac{y\,\epsilon}{\gamma^2}\,\frac{p}{f - p}.$$

And since

$$n\,L = L\sqrt{\frac{W}{E\,I}} = L\sqrt{\frac{p}{E\,\gamma^2}} = \frac{L}{\gamma}\sqrt{\frac{p}{E}}$$

$$\therefore \text{Sin.}\ \frac{L}{\gamma}\sqrt{\frac{p}{E}} = \frac{y\,\epsilon}{\gamma^2}\,\frac{p}{f - p}. \qquad (6)$$

This is a rational formua connecting $\frac{L}{\gamma}$ with p, and makes no assumption either regarding the form of the deflection curve or the omitting of the reaction at the ends.

If, in this equation, we put $\epsilon = 0$, then

$$\text{Sin.}\ \frac{L}{\gamma}\sqrt{\frac{p}{E}} = 0,$$

or

$$\frac{L}{\gamma}\sqrt{\frac{p}{E}} = \pi,$$

or

$$W = \frac{\pi^2\,E\,I}{L^2},$$

which is Euler's expression for the ideal column.

Again, for very long columns, the expression $\frac{p}{f - p}$ approaches zero, and in the limit we again have Euler's form, showing that the stress curve on a length ratio basis meets Euler's at infinity.

While no formula for the strength of columns which did not answer these tests could be strictly rational, it is evident that the Moncrief formula fails under both.

In Fig. 4 the curves of limiting loads are shown for mild steel, both for the Moncrief and for the above expression.

The value which Moncrief found for the eccentricity factor, $\frac{y\,\epsilon}{\gamma^2} = .6$, has been adopted in both cases for purposes of comparison. A table of the figured results is appended.

It may be noted here that the sine term entering into the above expression leads to no difficulty whatever, the labor being, in point of fact, much simplified.

$$\text{Putting } R = \frac{L}{\gamma}$$

$$\gamma = \frac{\epsilon\,y}{\gamma^2},$$

we have

$$\text{Sin.}\ R\sqrt{\frac{p}{E}} = \gamma\,\frac{p}{f - p},$$

or $$R = \left(\text{Sin.}^{-1}\, \gamma \frac{p}{f-p} \right) \sqrt{\frac{E}{p}}.$$

The general solution to an equation of the form Sin. $\theta = x$ is

$$\theta = S\,\pi - \text{Sin.}^{-1}\, x,$$

where S is any whole number. And in the above we must take

$$R = \left(\pi - \text{Sin.}^{-1}\, \gamma \frac{p}{f-p} \right) \sqrt{\frac{E}{p}}.$$

Example:

$\gamma = .6$, $f = 60{,}000$ pounds (inches)^2.
Suppose $p = 20{,}000$ pounds (inches)^2.
$E = 30{,}000{,}000$ pounds inches.

$$R = \left(\pi - \text{Sin.}^{-1}.6 \times \frac{60{,}000}{40{,}000} \right) \sqrt{\frac{30{,}000{,}000}{20{,}000}}$$

$$= (\pi - \text{Sin.}^{-1}.3)\, \frac{173.2}{4.47}$$

$$= (\pi - CM \text{ of } 17^\circ - 28')\, \frac{173.2}{4.47}$$

$$= (\pi - .3048)\, \frac{173.2}{4.47} = 110$$

As regards the point where the bending moment was a maximum we had

M_x is a maximum, where Sin. $nx = 1$, or where

$$nx = \frac{\pi}{2}, \text{ or } x = \frac{\pi}{2n}.$$

Taken in terms of the length of the column

$$\frac{x}{L} = \frac{\pi}{2nL} = \frac{\pi}{2R} \sqrt{\frac{p}{E}}.$$

The most stressed section is always above the middle of length.

An examination of the curve of ultimate stresses shows that there is a value of R greater than $R = 0$ ($R = 44.3$ for *M. S.*), at which the column is stressed to its limit by the direct action of the load alone, quite apart from the bending stress. For mild steel, assuming $\gamma = 6$, this limiting stress is 37,400 pounds, or about the elastic limit of the material.

Finally, as regards the validity of assuming $\frac{\epsilon y}{\gamma^2}$ = a constant quantity.

If we suppose γ to be a measure of the size of section, then we may take as a working basis $\epsilon \propto \gamma$, or $\epsilon = k\,\gamma$, when k is constant.

For a circular section, either solid or hollow (where the ratio of internal to external diameter is constant),

$$y = \gamma \times 4.$$

$$\text{So that } \frac{\epsilon y}{\gamma^2} = 4\,k = \text{constant.}$$

For a square section, either solid or hollow (where the ratio between the inside and outside dimensions is constant),

$$y = \gamma\, 2\, \sqrt{3},$$

$$\text{So that } \frac{\epsilon y}{\gamma^2} = 2\, \sqrt{3}\, k = \text{constant.}$$

It follows that γ is constant for either a circular or square section, but that it is greater for the former, and hence a curve should be drawn for each case, the square section being the weaker of the two.

The above formula may thus be made to take into account not only the size but the form of cross section.

(To be continued.)

Cost of Handling Coal and Iron Ore on the Great Lakes

Some remarkable figures regarding the cost of handling coal and iron ore on the American Great Lakes were given by Honorable William C. Redfield, in his address at the annual banquet of the Society of Naval Architects and Marine Engineers. As the figures referred to a medium-sized vessel, the cost of handling these commodities is undoubtedly less in such large freighters as were described in our issue of September, these vessels having a deadweight carrying capacity at 20-foot draft of 13,200 tons.

The figures given referred to a single trip up the Lakes and return. This trip is given as an average of the sixteen round-trips made in the season of six to seven months that navigation is open on the Lakes.

The trip occupied fourteen days, and on the way up the Lakes the vessel carried 5,669 tons of coal from Toledo to Port Arthur at 30 cents (1/3) a ton net, and on the return trip carried 6,631 tons of iron ore from Superior to Ashtabula at 50 cents (2/1) net per ton. The total receipts for the trip were $5,000 (£1,040).

The direct expenses were about $2,500 (£520), and the principal items in these expenses were as follows: Handling the cargo, $786 (£164), or 31.4 percent total; crew's wages, $685 (£143), or 27.4 percent; fuel, $636 (£133), or 25.4 percent; groceries and provisions, $166 (£35), or 6.6 percent; machinery and boiler repairs and renewals, $93 (£19), or 3.7 percent, and harbor towing $52 (£10 10s.), or 2 percent.

Of these different items of expense there is no allowance for insurance, but the average premiums for such a round trip would be about $750 (£135). The amount allowed for depreciation would vary according to the policy of the owners, but in this particular case the policy is to wipe the whole investment off in twenty years on the ground that the boat is likely to be displaced in that time by an improved type. This would make the depreciation account average about $800 (£168) a round trip.

There would be other small charges against the vessel, such as the annual cost for repairs to hull and machinery, possible commissions on securing cargo, and taxes; but even deducting these it is estimated that the vessel would make at the very least in her sixteen round trips over $10,000 (£2,085).

SAFETY AT SEA.—With a view to obtaining specific information from experts as to the character of structural arrangements of ships which should be required by national and international regulations to secure their safety at sea, the Department of Commerce, Washington, D. C., has appointed a joint committee of officers from the Department of the Navy and the Department of Commerce to prepare a list of questions relating to the bulkhead subdivision of vessels and other structural features affecting the safety of ships at sea. The members of the committee are: Washington L. Capps, formerly chief constructor U. S. N.; David W. Taylor, naval constructor U. S. N.; George Uhler, supervising inspector general, Steamboat Inspection Service; E. T. Chamberlain, Commissioner of Navigation. Aided by James Donald, naval architect of Boston, who has been designated by a committee of shipbuilders on the Atlantic coast as their representative before the Department of Commerce in the preliminary investigation involved, the committee has issued to naval architects and marine engineers a comprehensive list of questions concerning the subject of safety at sea, and it is hoped that these will receive careful consideration so that present conditions may be improved in this respect.

Empirical Method of Screw Propeller Design*

BY PETER DOIG

The following examples, it is hoped, will make plain the steps in the necessary calculations with the diagrams. It may be noted that the wake factors used are taken straight from the curves of Fig. 1 without modification for cutaway sterns. If this had been done still closer agreements than found would have been shown between the actual and designed wheels.

Case 1: A single-screw cargo tramp. S. S. *Vespasian.* See INTERNATIONAL MARINE ENGINEERING, 1910, page 256.

Here block coefficient = .754; horsepower = 993.

Speed = 10.2 knots; revolutions = 70.

H_d = 993 × engine efficiency × power factor.
= 993 × .84 × .98. (See Table 1 and Fig. 2.)
= 816.

A preliminary approximation to diameter is made from a similar ship or other method for use in Fig. 2. A considerable divergence from the final diameter makes very little difference in the power factor.

$S_a = 10.2 \times .75 = 7.65$. (See Fig. 1, Curve *C*.)

$$\text{Then } C_r = \frac{70}{7.65^2}\sqrt{\frac{816}{7.65}} = 1.195 \times 10.32 = 12.33.$$

Entering Fig. 4 at this C_r value we find that at the line for locus of best wheels the pitch ratio is 1.03. To obtain the corresponding diameter Fig. 5 is then consulted, and at C_r value 12.33 and pitch ratio 1.03 a C_d value of 11.45 is found by interpolation between lines 11 and 12. Hence using the formula:

$$\text{Diameter} = D = \frac{C_d}{S_a}\sqrt{\frac{H_d}{S_a}},$$

$$\text{the diameter results} = \frac{11.45 \times 10.32}{7.65} = 15.45 \text{ feet.}$$

This gives the dimensions of the best three-bladed wheel:

Diameter = 15.45 feet.
Pitch = 15.45 × 1.03 = 15.9 feet.

From Table 2 a helicoidal disk-area-ratio of .36 is obtained; and from Fig. 8 the pitch correction at this area-ratio and the C_r value as above is found to be 1.005, corrected pitch resulting = 1.005 × 15.9 = 16.0 feet. Helicoidal area = $15.45^2 \times .7854 \times .36 = 67.5$ square feet. This ship had a four-bladed propeller, so that the final solution is:

Diameter = 15.45 × .94 = 14.5 feet (14.0 feet).
Pitch = 16.0 feet (16.35 feet).
Helicoidal surface = 67.5 square feet (70 square feet).

The figures in parentheses are the dimensions of the actual wheel. This applies throughout the following examples:

Case 2: A twin-screw collier; three-bladed propellers. T. S. S. *Orion.* See *Journal American Society Naval Engineers,* 1912, page 1254.

Here block coefficient = .715; horsepower = 6943 (two shafts).

Speed = 14.47 knots; revolutions = 95.

$$H_d = \frac{6943}{2} \times .86 \times .98 = 2920. \text{ (Table 1, Fig. 2.)}$$

$S_a = 14.47 \times .825 = 11.95$. (Fig. 1, Curve *A*.)

$$C_r = \frac{95}{11.95^2}\sqrt{\frac{2920}{11.95}} = .664 \times 15.63 = 10.39.$$

On Fig. 4, pitch ratio of best wheel = 1.07; on Fig. 5, C_d corresponding = 12.7.

$$\text{Whence diameter} = \frac{12.7 \times 15.63}{11.95} = 16.6 \text{ feet (16.5 feet).}$$

Pitch = 16.6 × 1.07 = 17.8 feet (18.0 feet).

Helicoidal surface = $16.6^2 \times .7854 \times .375 = 81.5$ square feet (82.5 square feet).

Disk-area-ratio from Table 2 being .375, with pitch correction negligible.

Case 3: A twin-screw battleship with reciprocating engines; three-bladed. United States battleship *Delaware. Journal American Society Naval Engineers,* 1911, page 672.

Here block coefficient = .600; horsepower = 26,500 (two shafts).

Speed = 21.4 knots; revolutions = 126.8.

$$H_d = \frac{26{,}500}{2} \times .88 \times .98 = 11{,}400. \text{ (Table 1, Fig. 2.)}$$

$S_a = 21.4 \times .87 = 18.62$. (Fig. 1, Curve *A*.)

$$C_r = \frac{126.8}{18.62^2}\sqrt{\frac{11{,}400}{18.62}} = .366 \times 24.75 = 9.06.$$

On Fig. 4, pitch ratio of best wheel = 1.11; on Fig. 5, C_d corresponding = 13.65.

$$\text{Whence diameter} = \frac{13.65 \times 24.75}{18.62} = 18.15 \text{ feet (18.25 feet).}$$

Pitch = 18.15 × 1.11 = 20.1 feet (19.75 feet).

Helicoidal surface = $18.15^2 \times .7854 \times .40 = 104$ square feet (106 square feet).

Disk-area-ratio from Table 2 being .40; with no pitch correction (Fig. 8).

Case 4: A twin-screw scout cruiser; reciprocating engines; three-bladed screws. United States cruiser *Birmingham. Journal American Society Naval Engineers,* 1908, page 726.

Here block coefficient = .40; horsepower = 15,476 (two shafts).

Speed = 24.33 knots; revolutions = 191.6.

$$H_d = \frac{15{,}476}{2} \times .90 \times .975 = 6790. \text{ (Table 1, Fig. 2.)}$$

$S_a = 24.33 \times .94 = 22.9$. (Fig. 1, Curve *A*.)

$$C_r = \frac{191.6}{22.9^2}\sqrt{\frac{6790}{22.9}} = .365 \times 17.22 = 6.29.$$

On Fig. 4, pitch ratio of best wheel = 1.24; on Fig. 5, C_d corresponding = 16.6.

$$\text{Whence diameter} = \frac{16.6 \times 17.22}{22.9} = 12.48 \text{ feet (12.5 feet).}$$

Pitch = 12.48 × 1.24 = 15.47 feet (15.25 feet).

Helicoidal surface = $12.48^2 \times .7854 \times .40 = 49$ square feet (49 square feet).

Disk-area-ratio from Table 2 being .40; with no pitch correction (Fig. 8).

* Concluded from the June issue. For the illustrations mentioned in this article the reader is referred to pages 242, 243 and 244 of the June issue.

EXAMPLES IN DESIGN OF TURBINE-DRIVEN WHEELS

Case 5: Triple-screw fast passenger steamer reaction turbines; three-bladed screws. *Camden. Journal American Society Naval Engineers,* 1907, page 723.

Center Screw: Block coefficient = .540; speed = 19.0 knots. Brake horsepower = 1550; revolutions = 543.

$$Ha = 1550 \times .98 \times .94 = 1427. \text{ (Table 1, Fig. 2.)}$$

$$Sa = 19.0 \times .79 = 15.0. \text{ (Fig. 1, Curve } E.\text{)}$$

$$Cr = \frac{543}{15^2}\sqrt{\frac{1427}{15}} = 2.41 \times 9.75 = 23.5.$$

From Fig. 6 $Ca = 7.85$; from Fig. 5 at Cr 23.5 and Ca 7.85, pitch ratio = .90.

Whence diameter $= \frac{7.85 \times 9.75}{15.0} = 5.10$ feet, and pitch for .40 disk-area-ratio (helicoidal) = $5.10 \times .90 = 4.59$ feet.

From Fig. 7 at 543 revolutions the projected disk-area-ratio = .50.

Helicoidal disk-area-ratio corresponding = .50 (.80 + .90 × .33) = .55.

From Fig. 8 at .55 disk-area-ratio and $Cr = 23.5$, pitch correction = .975.

The propeller indicated is

Diameter = 5.10 feet (5.0 feet).

Pitch $4.59 \times .975 = 4.48$ feet (4.5 feet).

Helicoidal surface $5.1^2 \times .7854 \times .55 = 11.3$ square feet (10 square feet).

Side Screws: Horsepower = 1490 (one shaft); revolutions = 561.

$$Ha = 1490 \times .98 \times .94 = 1372. \text{ (Table 1, Fig. 2.)}$$

$$Sa = 19.0 \times .885 = 16.8. \text{ (Fig. 1, Curve } D.\text{)}$$

$$Cr = \frac{561}{16.8^2}\sqrt{\frac{1372}{16.8}} = 1.985 \times 9.03 = 17.93.$$

From Fig. 6 $Ca = 9.4$; from Fig. 5 at Cr 17.93 and Ca 9.4, pitch ratio = .90, whence diameter $= \frac{9.4 \times 9.03}{16.8} = 5.05$ feet, and pitch for .40 disk-area-ratio (helicoidal) = $5.05 \times .90 = 4.54$ feet.

The helicoidal disk-area-ratio and pitch correction result as in the center screw, the propeller indicated being:

Diameter = 5.05 feet (5.0 feet).

Pitch $= 4.54 \times .975 = 4.44$ feet (4.5 feet).

Helicoidal surface $= 5.05^2 \times .7854 \times .55 = 11.0$ square feet (10 square feet).

Case 6: Twin-screw high-speed scout cruiser; impulse turbines; three-bladed screws. U. S. S. *Salem.* See *Journal American Society Naval Engineers,* 1908, page 991.

Here block coefficient = .400; horsepower = 19,200 (two shafts.

Speed = 25.95 knots; revolutions = 378.3.

$$Ha = \frac{19{,}200}{2} \times .98 \times .97 = 9120. \text{ (Table 1, Fig. 2.)}$$

$$Sa = 25.95 \times .94 = 24.4. \text{ (Fig. 1, Curve } A.\text{)}$$

$$Cr = \frac{378.3}{24.4^2}\sqrt{\frac{9120}{24.4}} = .636 \times 19.35 = 12.3.$$

From Fig. 6 $Ca = 12.3$; from Fig. 5 at Cr 12.3 and Ca = 12.3, pitch ratio = .89.

Whence diameter $= \frac{12.3 \times 19.35}{24.4} = 9.75$ feet, and pitch for .40 helicoidal disk-area-ratio $= 9.75 \times .89 = 8.67$ feet.

From Fig. 7 at 378 revolutions the projected area ratio = .53. Helicoidal ratio corresponding = .53 (.80 + .89 × .33) = .58.

From Fig. 8 at .58 disk-area-ratio and $Cr = 12.3$, pitch correction = .98. The solution is, therefore,

Diameter = 9.75 feet (9.5 feet).

Pitch $= 8.67 \times .98 = 8.48$ feet (8.7 feet).

Helicoidal surface $= 9.75^2 \times .7854 \times .58 = 43.2$ square feet (43.7 square feet).

Case 7: Quadruple-screw battleship; reaction turbines; three-bladed screws. U. S. B. S. *Utah.* See *Journal American Society Naval Engineers,* 1911, page 670.

Outer Shafts: Block coefficient = .584; horsepower = 6770 (one shaft).

Speed = 21.04 knots; revolutions = 327.3.

$$Ha = 6770 \times .98 \times .96 = 6360. \text{ (Table 1, Fig. 2.)}$$

$$Sa = 21.04 \times .84 = 17.65. \text{ (Fig. 1, Curve } F.\text{)}$$

$$Cr = \frac{327.3}{17.65^2}\sqrt{\frac{6360}{17.65}} = 1.05 \times 18.98 = 19.95.$$

From Fig. 6 $Ca = 8.7$; from Fig. 5 at $Cr = 19.95$ and Ca = 8.7, pitch ratio = .90.

Whence diameter $= \frac{8.7 \times 18.98}{17.65} = 9.35$ feet, and pitch for .40 helicoidal disk-area-ratio $= 9.35 \times .90 = 8.42$ feet.

From Fig. 7 at 327 revolutions projected disk-area-ratio = .53. Helicoidal disk-area-ratio corresponding = (.80 + 90 × .33) .53 = .58.

From Fig. 8 at .58 disk-area-ratio and $Cr = 19.95$, pitch correction = .975. The propeller indicated is

Diameter = 9.35 feet (9.17 feet).

Pitch $= 8.42 \times .975 = 8.20$ feet (8.5 feet).

Helicoidal surface $= 9.35^2 \times .7854 \times .58 = 40$ square feet (41 square feet).

Inner Shafts: Abbreviating the above procedure:

$Ha = 6740 \times .98 \times .96 = 6330$ (Table 1, Fig. 2); $Sa = 21.04 \times .81 = 17.05$. (Fig. 1, Curve *G.*)

$$Cr = \frac{319.8}{17.05^2}\sqrt{\frac{6330}{17.05}} = 1.10 \times 19.26 = 21.2;\ Ca$$

corresponding = 8.4. (Fig. 6.)

Diameter $= \frac{8.4 \times 19.26}{17.05} = 9.48$ feet.

Pitch ratio at .40 disk-area-ratio = .90; pitch = $9.48 \times .90 = 8.53$ feet.

Pitch correction at .58 disk-area-ratio = .975.

Wheel indicated:

Diameter = 9.48 feet (9.17 feet).

Pitch $= 8.53 \times .975 = 8.32$ feet (8.5 feet).

Helicoidal surface = 41 square feet (41 square feet).

Case 8: Twin-screw battleship; impulse turbines; three-bladed screws. U. S. B. S. *North Dakota.* See *Journal American Society Naval Engineers,* 1911, page 678.

Here block coefficient = .60; horsepower, 15,650 (one shaft).

Speed = 21.66; revolutions, 280.4.

Abbreviating the procedure:

$Ha = 15{,}650 \times .98 \times .975 = 14{,}950$; $Sa = 21.66 \times .88 = 19.05$.

$$Cr = \frac{280.4}{19.05^2}\sqrt{\frac{14{,}950}{19.05}} = .773 \times 28.0 = 21.65;\ Ca$$

corresponding = 8.85. (Fig. 6.)

$$\text{Diameter} = \frac{8.85 \times 28.0}{19.05} = 13.0 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .80; pitch = 13.0 × .80 = 10.4 feet.

Projected disk-area-ratio from Fig. 7 = .50.

Helicoidal ratio corresponding = .50 (.80 + .80 × 33) = .53.

Pitch correction = .98. (Fig. 8.)

Wheel indicated:

Diameter = 13.0 feet (13.0 feet).

Pitch = 10.4 × .98 = 10.2 feet (10.3 feet).

Helicoidal surface 70½ square feet (71.3 square feet).

Case 9: A quadruple-screw high-speed scout cruiser; reaction turbines; three-bladed propellers. U. S. S. *Chester*. See *Journal American Society Naval Engineers*, 1911, page 678.

Here block coefficient = .40; speed = 25.9 knots.

Outer shafts:

$$H_d = 5680 \times .98 \times .955 = 5320; \quad S_a = 25.9 \times .90 = 23.3.$$

$$C_r = \frac{604.4}{23.3^2}\sqrt{\frac{5320}{23.3}} = 1.113 \times 15.1 = 16.8; \quad C_d \text{ corresponding} = 9.85. \text{ (Fig. 8.)}$$

$$\text{Diameter} = \frac{9.85 \times 15.1}{23.3} = 6.38 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .91; pitch = 6.38 × .91 = 5.8 feet.

Projected area ratio from Fig. 7 = .60.

Helicoidal ratio corresponding = .60 (.80 + .91 × .33) = .66.

Pitch correction = .975. (Fig. 8.)

Wheel indicated:

Diameter = 6.38 feet (6.0 feet).

Pitch = 5.8 × .975 = 5.65 feet (6.0 feet).

Helicoidal surface = 21 square feet (19 square feet).

Inner Shafts:

$$H_d = 6300 \times .98 \times .955 = 5900; \quad S_a = 25.9 \times .85 = 22.0.$$

$$C_r = \frac{602.5}{22^2}\sqrt{\frac{5900}{22}} = 1.244 \times 16.4 = 20.4; \quad C_d \text{ corresponding} = 8.6. \text{ (Fig. 6.)}$$

$$\text{Diameter} = \frac{8.6 \times 16.4}{22} = 6.41 \text{ feet.}$$

Pitch ratio at .40 disk-area-ratio = .90; pitch = 6.41 × .90 = 5.77 feet.

Projected area ratio from Fig. 7 = .60; helicoidal ratio = .66.

Pitch correction .97. (Fig. 8.)

Wheel indicated:

Diameter = 6.41 feet (6.0 feet).

Pitch = 5.77 × .97 = 5.60 feet (6.0 feet).

Helicoidal surface = 21 square feet (19 square feet).

Case 10: A twin-screw destroyer; impulse turbines; three-bladed screws. U. S. T. B. D. *Warrington*. See *Journal American Society Naval Engineers*, 1911, page 968.

Here horsepower = 12,846 (two shafts); revolutions = 641.

Speed = 30.12 knots.

Here wake factor = 1.03 (see page 243, June issue); S_a = 30.12 × 1.03 = 31.02.

$$H_d = \frac{12{,}846}{2} \times .98 \times .96 = 6040.$$

$$C_r = \frac{641}{31.02^2}\sqrt{\frac{6040}{31.02}} = .665 \times 13.94 = 9.27; \quad C_d \text{ corresponding} = 15.1. \text{ (Fig. 6.)}$$

Pitch ratio at .40 helicoidal disk-area-ratio = .90. (Fig. 5.)

$$\text{Whence diameter} = \frac{15.1 \times 13.94}{31.02} = 6.78 \text{ feet, and pitch} = 6.78 \times .90 = 6.1 \text{ feet.}$$

From Fig. 7 projected disk-area-ratio = .57.

Helicoidal disk-area-ratio corresponding = .57 (.80 + .90 × .33 = .63.

Pitch correction from Fig. 8 = .985.

The propeller indicated is, therefore,

Diameter = 6.78 feet (6.67 feet).

Pitch = 6.1 × .985 = 6.0 feet (6.17 feet).

Helicoidal surface = 22½ feet (23 square feet).

Case 11: A triple-screw destroyer; reaction turbines; three-bladed screws. U. S. T. B. D. *Flusser*. See *Journal American Society Naval Engineers*, 1910, page 32. Going through the design in the foregoing order we get:

Wing Screws:

$$H_d = 3923 \times .98 \times .945 = 3635; \quad S_a = 30.41 \times 1.04 = 31.65. \text{ (See } \textit{ante}.\text{)}$$

$$C_r = \frac{806}{31.65^2}\sqrt{\frac{3635}{31.65}} = .805 \times 10.69 = 8.61; \quad C_d \text{ corresponding} = 15.4.$$

Pitch ratio at .40 helicoidal disk-area-ratio = .96.

$$\text{Whence diameter} = \frac{15.4 \times 10.69}{31.65} = 5.2 \text{ feet; pitch} = 5.2 \times .96 = 5.00 \text{ feet.}$$

From Fig. 7 projected disk-area-ratio = .64; helicoidal ratio corresponding = .72.

Pitch correction = .983. Propeller indicated:

Diameter = 5.20 feet (5.25 feet).

Pitch = 5.00 × .983 = 4.91 feet (4.83 feet).

Helicoidal surface = $5.2^2 \times .7854 \times .72$ = 15.3 square feet (15 square feet).

Center Screw: Here "*W*" = 1.02; S_a = 30.41 × 1.02 = 31.05.

Revolutions and power are such that

$$C_r = \frac{790}{31.05^2}\sqrt{\frac{3425}{31.05}} = .819 \times 10.5 = 8.6.$$

The C_d corresponding is 15.4; both these values being the same as in the wing screws. This gives the same solution as the wing screws.

Examples in Small Craft

Case 12: Single-screw steam launch; two-bladed propeller. (See Durand, Resistance and Propulsion of Ships, page 422.)

Here horsepower = 39.3; revolutions = 196.5.

Speed = 8.5 knots; length = 54.8 feet.

$$\frac{\text{speed}}{\sqrt{\text{length}}} = \frac{8.5}{\sqrt{54.8}} = 1.15; \text{ from Fig. 3, "}W\text{"} = .81.$$

S_a = 8.5 × .81 = 6.89; H_d = 39.3 × .90 × .94 = 33.3. (Table 1, Fig. 2.) (Preliminary estimate of diameter being 4 to 5 feet.)

$$C_r = \frac{196.5}{6.89^2}\sqrt{\frac{33.3}{6.89}} = 4.13 \times 2.20 = 9.10.$$

Pitch ratio of best three-bladed wheel of .40 disk-area-ratio = 1.12. (Fig. 4.)

C_a corresponding (Fig. 5) = 13.7.

$$\text{Diameter} = \frac{13.7 \times 2.20}{6.89} = 4.38 \text{ feet.}$$

The best three-bladed wheel for the revolutions and power would therefore have (adopting .40 area ratio from Table 2):

Diameter, 4.38 feet; pitch, $4.38 \times 1.12 = 4.91$ feet; helicoidal surface = 6 square feet.

The equivalent two-bladed wheel is:

Diameter = $4.38 \times 1.04 = 4.56$ feet (4.33 feet).

Pitch = 4.91 feet (5.14 feet).

Helicoidal surface = 6 square feet (6.13 square feet).

Case 13: Racing displacement motor boat; single screw; three-bladed. *Dixie II.* See *Transactions Society Naval Architects and Marine Engineers,* 1905, page 368.

Here B. H. P. of gasoline (petrol) engine = 170 (see below); revolutions = 1120.

Speed = 26 knots; length = 40 feet.

$$\frac{\text{speed}}{\sqrt{\text{length}}} = \frac{26}{\sqrt{40}} = 4.1; \text{ from Fig. 3, "}W\text{"} = .92.$$

$S_a = 26 \times .92 = 23.9$; $H_a = 170 \times .95 \times .86 = 139$. (Table 1, Fig. 2.) (Preliminary estimate of diameter being about 2 feet.)

$$C_r = \frac{1120}{23.9^2}\sqrt{\frac{139}{23.9}} = 1.955 \times 2.41 = 4.70.$$

Pitch ratio of best three-bladed wheel of .40 area ratio = 1.38. (Fig. 4.)

C_a corresponding (Fig. 5) = 19.0.

$$\text{Diameter} = \frac{19.0 \times 2.41}{23.9} = 1.92 \text{ feet.}$$

From Table 2 a disk-area-ratio of .55 is obtained.

Pitch correction = .993. (Fig. 8.)

Whence the screw indicated is:

Diameter = 1.92 feet (1.95 feet).

Pitch = $1.92 \times 1.38 \times .993 = 2.63$ feet (2.67 feet).

Helicoidal surface = $1.92^2 \times .7854 \times .55 = 1.6$ square feet (1.64 square feet).

The rated power of this engine was 150, but the usual formula for power of gasoline engines gives 170 as above.

The Compensating Quadrant Crane

BY HARRY W. BROADY*

The new type of crane which was described briefly on page 509 of the December, 1911, issue of INTERNATIONAL MARINE ENGINEERING, has aroused considerable interest, and inquiries have been made for further information on this subject. It is the object of this paper to answer these inquiries, and to give, both from the technical and from the practical side, a more or less detailed description of this new crane.

The crane is an invention of Capt. A. P. Lundin and Axel Welin, and since the first time mentioned several cranes of this type have been built, thus making it possible to give a more complete description of the construction and operation.

The compensating quadrant crane is a derrick crane; that is, a crane with a jib or girder that can be raised or lowered. The jib is securely fastened at its lower end to two quadrants. In smaller cranes the jib and the quadrant are cast in one piece. The circumferential part of the quadrant has both a finished surface rolling in a slot and teeth that engage in a rack. The slot and the rack are cast in the bottom plate. A frame work is built up on the bottom plate, consisting of a frame forward and one aft, with a connecting top piece. The actuating screw or screws work in bearings in this top part, which part also holds the bearing at the top of the post. The bearing at the bottom of the post is a part of the bottom plate. This actuating screw swings the quadrant by means of a nut which slides on a guide on the top part of the frame. The bottom plate is provided with four rollers for slewing, that roll on a beveled flange on the post plate.

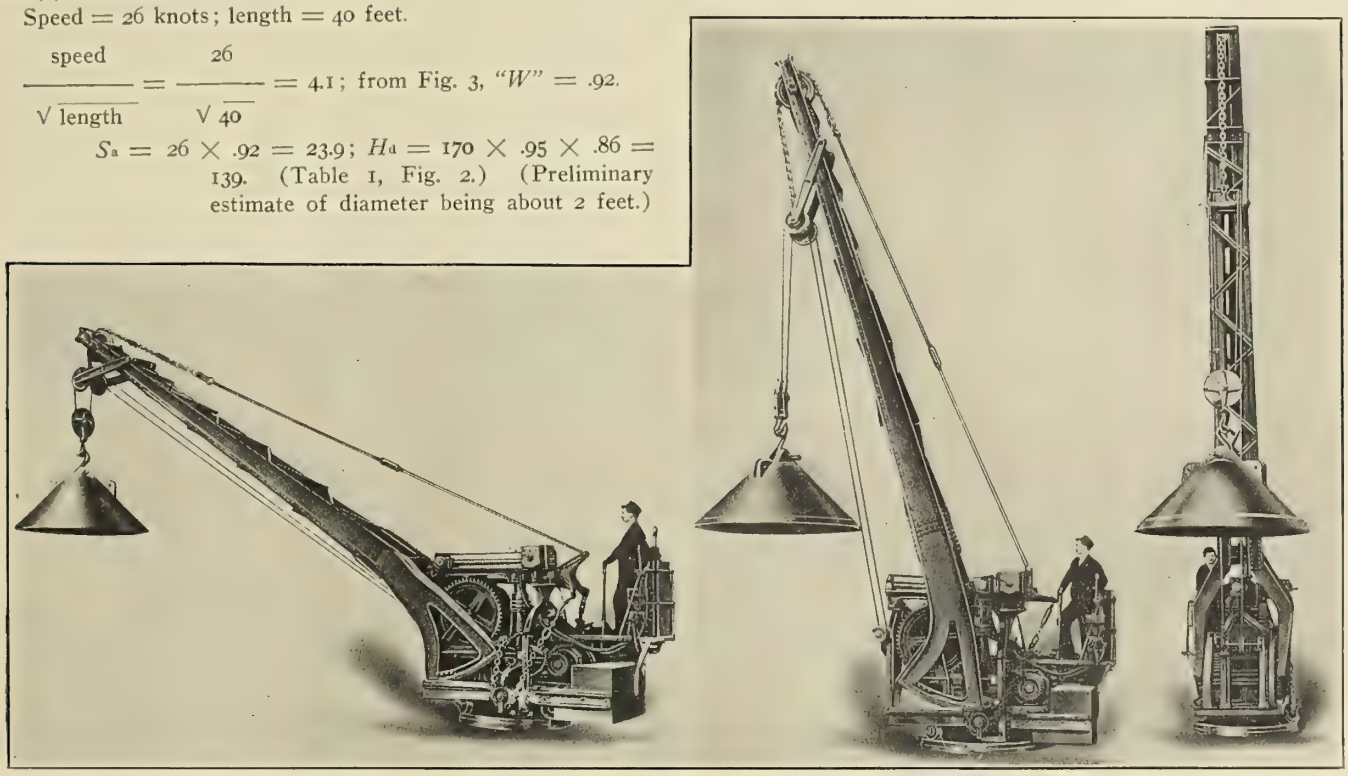

FIG. 1.—2½ TO 4-TON, THREE MOTOR, COMPENSATING QUADRANT CRANE

There are two different compensating devices. The first is obtained by the use of two parallel links pivoted in one end near the top of the jib, and at the other end holding two sheaves over which the hoisting ropes run. This end of the links is held by a chain that runs over the sheave at the top of the jib, and is connected by means of a rod with a three-

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arm dog pivoted at the top of the back frame. The other two arms of the dog are connected with the lower back end of the quadrants by means of two chains running over sheaves on the bottom plate.

In the second alternative device for compensation, the fixed end of the hoisting rope is fastened to the jib at a suitable point near the top, and from this point runs back and forth over sheaves on the back part of the frame and on the top of the jib.

The hoisting machinery is of the usual kind suitable for the purpose for which the crane is to be used—that is, hoisting drum, brake, gearing, friction clutch and other necessary details. The slewing is obtained by means of a system of gears under the bottom plate, which engages an annular rack in the post plate. The derricking is accomplished by means of the above-mentioned actuating screw, which is provided with a worm or spur gear drive. The necessary counterbalancing is properly cared for by a well-secured weight. The driving power can be of any desired kind, but the cranes here are generally provided with electric motors.

The crane shown in Fig. 1 is a 2½ to 4-ton three-motor crane, one motor for hoisting, one for slewing and one for derricking. Levers, controllers and all other necessary parts for operating the crane are placed conveniently on a platform. A one-motor 3-ton crane is shown in Fig. 2, and a 1-ton truck crane in Fig. 3.

Four distinct features make the compensating quadrant crane different from other cranes.

1. The rolling quadrant arrangement giving the jib a movable pivoted point.

2. The actuating screw arrangement with the application and direction of the derricking forces on the jib.

3. The horizontal travel of the load.

4. The compensation tending to reduce bending in the jib in proportion to the load.

The rolling quadrant arrangement is perhaps the most notable feature and gives the crane a distinctive look. It also gives a different arrangement of forces than on other cranes, which can be readily seen on the stress sheets, Figs. 4, 5 and 6, showing the stresses in different positions of the jib.

By rolling the jib on narrow circular flanges of a large radius, and controlling the position of the supporting point by means of a rack, no excessively large bearing surfaces are needed, giving a very large pin friction. The only friction worth mentioning at all is in the rack, and this is almost negligible, as it is spur-gear friction.

As the quadrant is part of a circle that has its center in

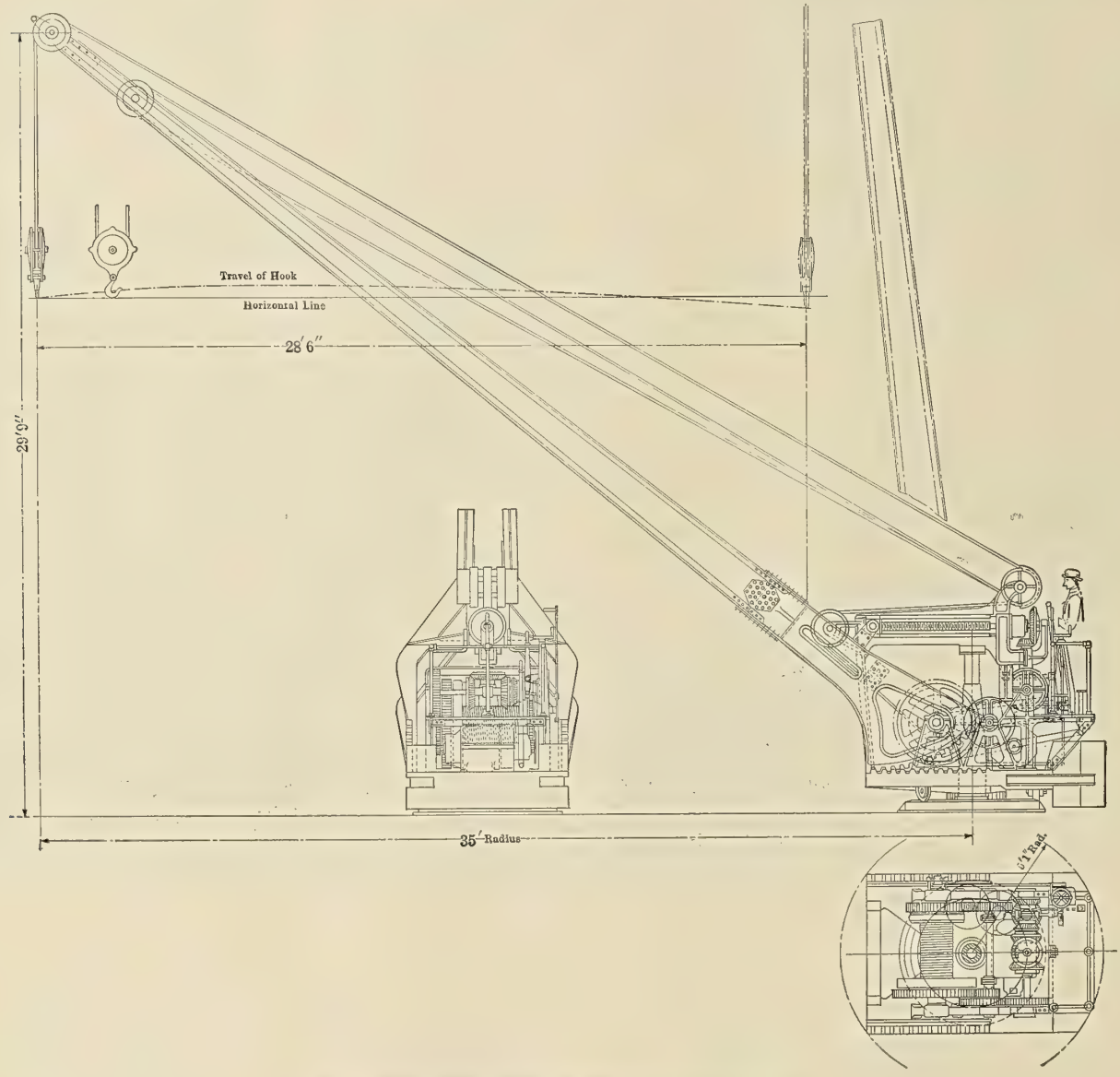


FIG. 2.—ONE MOTOR, 3-TON COMPENSATING QUADRANT CRANE

the center line of the actuating screw, and as this center line is parallel to the tangent of the quadrant at its supporting point, it will be readily understood that the force applied in the screw will always be at right angles to the line between the moving fulcrum and the point of support of the quadrant. That means the maximum leverage, consequently the minimum force needed for raising the jib. The required power for derricking is therefore minimized, and furthermore decreases rapidly the higher the jib is raised. It also follows from this that there is no bending in the screw, only tension.

The above arrangement does not cause any pressure to be communicated along the jib to the point of support. On

FIG. 3.—1-TON TRUCK CRANE

ordinary cranes the derricking arrangement causes a considerable pressure along the jib on the pivot, and to reduce that somewhat, and also to reduce the power required for derricking, the point of the upper support is placed as high as possible, sometimes on a mast or a structure. This increases the amount of material and necessitates guys and stays, thus materially reducing the slewing angle.

On the compensating quadrant crane this is absolutely unnecessary, and a low, compact arrangement can be used, giving a clear swing of 360 degrees.

The compensating arrangement, as previously mentioned, has two distinct functions. The most important one is to give the load a horizontal travel. The two different arrangements mentioned before show practically the same result, and the travel of the load is clearly seen on the stress sheets. At the beginning the path of travel rises from 1 to 3 inches. It is intended not to compensate for this small rise, as it eliminates the necessity of hoisting the load to clear before derricking, thus utilizing the least amount of power and reducing the time for loading and unloading. With a multiple speed crane of this type different sizes of loads can be taken readily without changing the gearing.

That it is advantageous to have the load traveling in a horizontal line is readily understood when one considers that to move a load horizontally requires practically no power. It is only necessary to apply power enough to bring the load up to the required horizontal speed. The power that is required for derricking is used in raising the resultant center of gravity of the moving parts to give the accelerated horizontal motion at the start and to overcome friction. In an ordinary crane the load is raised considerably when derricking, thus requiring an extra amount of power over that used in a compensating quadrant crane, and consequently increasing the running cost of the crane.

The compensating devices have still another important influence on the working of the compensating quadrant crane. By the arrangement of the two links in the first-mentioned device it can readily be seen on the stress sheet, Fig. 4, that these links materially reduce the bending and the pressure on the jib, while at the same time they help in making the travel of the load horizontal. Furthermore, those links tend to steady the sheaves over which the hoisting ropes run.

By means of the chains, the rod and the dog which connect

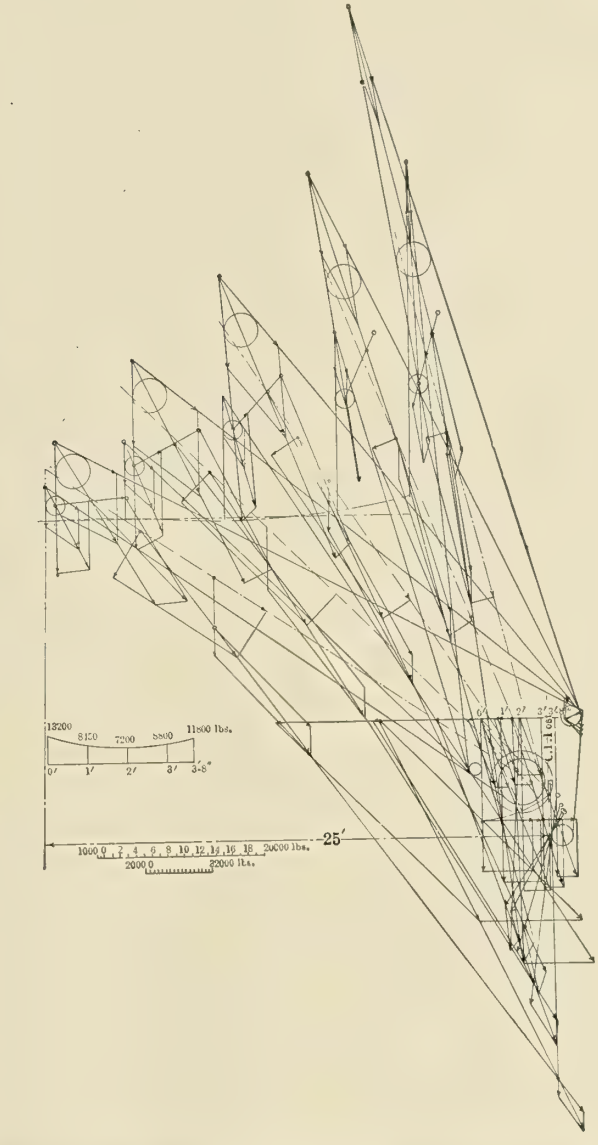


FIG. 4.—STRESS DIAGRAM FOR 2½ TO 4-TON COMPENSATED QUADRANT CRANE 25 to 20 FEET OUTREACH

the links with the quadrants, a force is produced that tends to reduce the tension in the actuating screw. The direction of the pressure transmitted through the dog on the top part of the aft frame is such that a lighter construction of the framework is possible than if a stay was connected to the frame, as is done in an ordinary crane. The first gives a downward pressure, as against an upward pull as well as bending in the latter.

With the second compensating device a practically horizontal travel of the load is obtained when derricking; at the same time a considerable force is produced that reduces the bend-

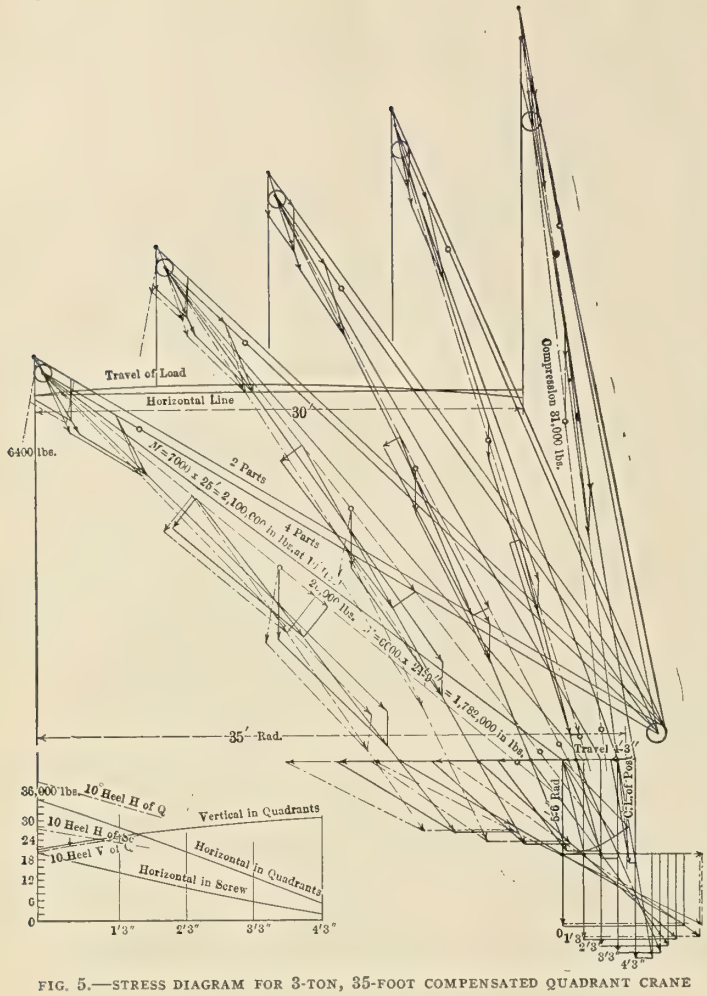


FIG. 5.—STRESS DIAGRAM FOR 3-TON, 35-FOOT COMPENSATED QUADRANT CRANE

ing force on the jib and the tension in the actuating screw, as can be seen in Figs. 5 and 6.

In both cases the compensating action of the forces is more and more effective as the load increases. This is one of the important features in the compensating quadrant crane, and which accounts for the relatively small increase in the derricking power needed for a large increase of the load. A convincing example of this fact is that on the crane shown in Fig. 1 the increase in power necessary for derricking was only about 30 percent from no load to full load. In considering the amount of power needed for derricking one must remember that the power decreases rapidly as the jib is raised.

The above-mentioned facts prove clearly that in this new type of crane the power and therefore the cost of derricking is reduced to figures never before possible. The importance of this fact is self-evident.

It is obvious by the action of the compensating devices that the dimensions of the jib can be materially reduced as compared with an ordinary crane, which is, of course, a much desired feature. Not only the weight of the crane but also the necessary counterweight is reduced. The construction is simplified and the number of parts are reduced, as can be seen on the plans, thus reducing weight, cost and space. It therefore follows that this crane, owing to the compactness of the design, can be used where other cranes would not be available.

A splendid example of this is the truck crane shown in Fig. 3. This is claimed to be the only type of crane that has worked out satisfactorily on self-loading motor trucks.

It is impossible in this article to more than mention a few of all the different arrangements and classes of work for which this crane can be used to advantage. Many new fields of vast importance are opened through the use of this crane. As an example, there is a tandem arrangement worked out which will double the capacity of the ordinary crane, but can be handled by only one man.

On the stress sheet, Fig. 6, the layout of a 20-ton crane is shown. The jib is arranged on the crane so that it can be lowered down to a horizontal position. In this position the jib will stand a load of about 10,000 pounds, making possible the handling of smaller loads at a considerably greater radius than in the usual arrangement. It is very interesting

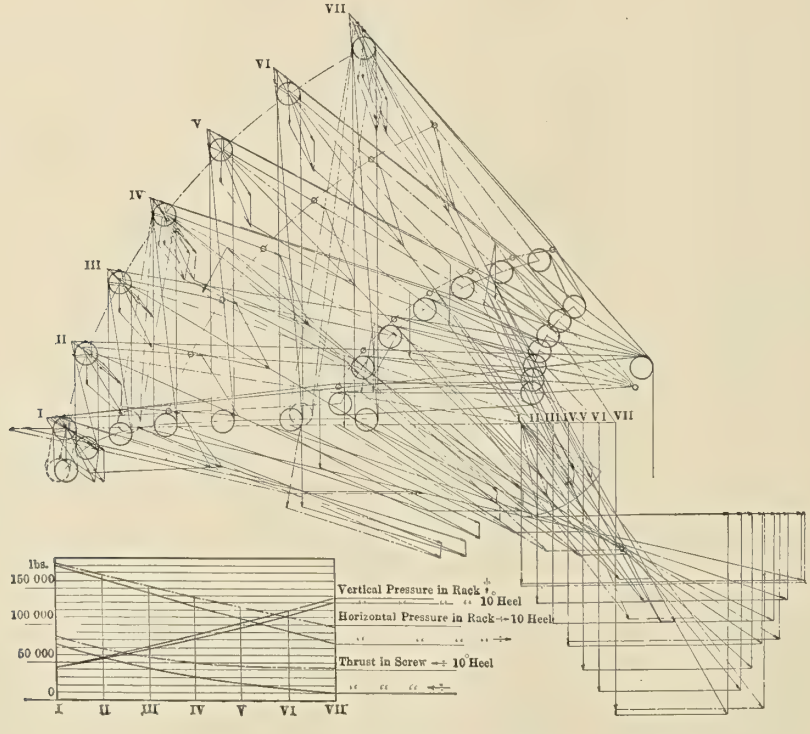


FIG. 6.—40,000-POUND COMPENSATED QUADRANT CRANE

to note that in this severe condition, in the line of travel of the load, there is only a comparatively slight rise in the beginning, and from there on a practically horizontal line. The jib of this crane can very readily be raised to its working position, thus making this type of compensating quadrant crane especially adaptable for locomotive cranes, wrecking cranes, battleship cranes, etc.

In connection with the easy manner in which the jib can be raised, it is worth while to point out another important feature: when an unusually heavy load is going to be handled, and slewing is necessary, the easy derricking of the jib makes it convenient to bring the load in near the center of the crane and then slew it, after which the jib is let out again to place the load in the desired position. The advantage of this on board ship when the ship has a list is obvious.

Another arrangement is with a variable quadrant radius, thus making still further compactness available in the crane. This is of great advantage in larger sizes.

The new counterweight arrangement shown in Fig. 7 will prove of special advantage in large cranes, as the effect of the counterweight is automatically regulated to suit the different positions of the load. At the same time the pull on the jib will tend to materially reduce the tension in the actuating screw, thus still further reducing the power needed for derricking. In a few words, the counterweight acts also as a compensating device on the jib.

In the cranes of this type steel castings of best grade are used wherever possible, and all other parts are made of the most suitable material. The actuating screw, for instance, is made of the best nickel steel. Ball bearings are provided at several points of contact, thus reducing the friction, and therefore the running cost of the cranes. The cranes are sold by the Welin Marine Equipment Company, 305 Vernon avenue, Long Island City, N. Y., and the La Salle Machine & Tool Company, of La Salle, Ill. In Europe they are sold by the Welin Davit Engineering Company, 5 Lloyds avenue, London.

In conclusion, I wish to give a summary of all the advantages distinctly characteristic of the compensating quadrant crane as follows: 1. Money saving, as less power is needed. 2. Time saving, by speedier load handling. 3. Less space needed. 4. Less weight. 5. Less machinery. 6. No mast or mast guys. 7. Easier to operate, being more compact. 8. Full swing of 360 degrees. 9. More adaptable.

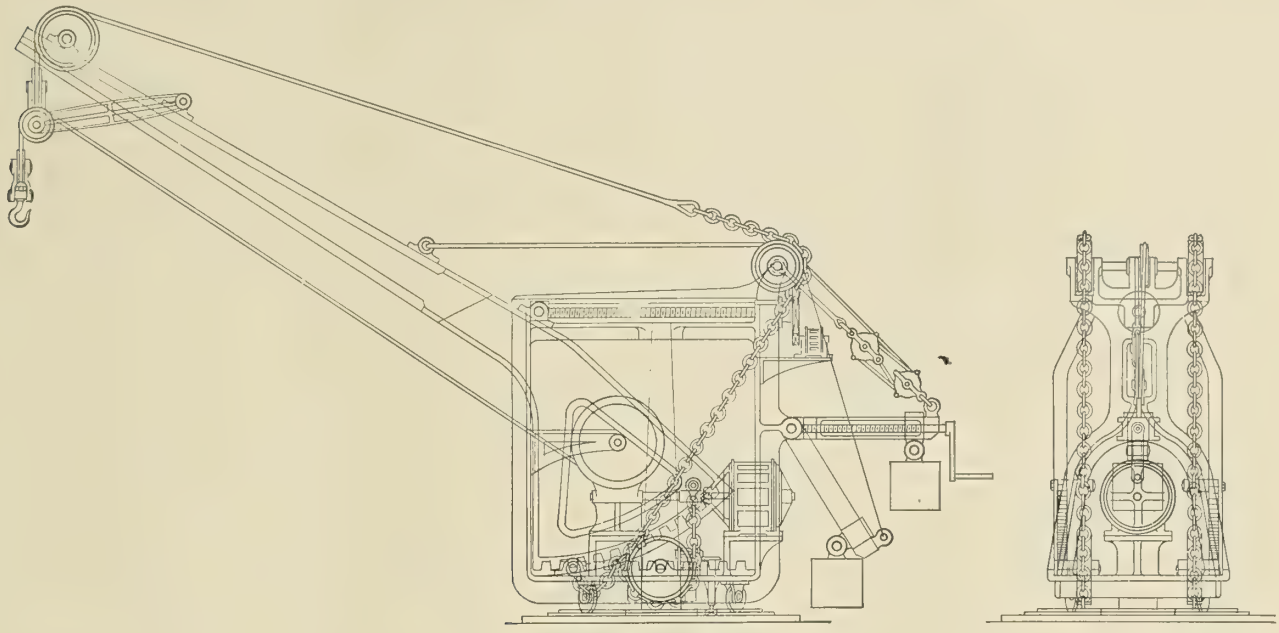


FIG. 7.—NEW COUNTERWEIGHT ARRANGEMENT ON COMPENSATING CRANE

5,000 Horsepower Motor Ship for the United States Navy

During the last regular session of Congress an appropriation was made for two oil fuel carriers. For one of these ships, the *Maumee,* the Navy Department has just concluded a contract with the New London Ship & Engine Company, Groton, Conn., whereby that company will supply complete working plans for two large oil engines of the Nuremberg type. While the exact details in regard to the ship and her engines are not available, it is definitely known that there will be two engines, each of six cylinders and developing 2,500 horsepower, making a total for the ship of 5,000 horsepower. Up to this time the largest marine engine to be built in the United States is one of 1,000 horsepower for the submarine tender *Fulton,* for which the New London Ship & Engine Company has a contract.

It is interesting to note that the advantages of oil propulsion are so well recognized that there have already been built abroad over seventy-five vessels exceeding 100 feet in length which now use oil engines. Fifty-three other vessels are now building, some of them even larger than their predecessors, all using internal-combustion engines of the Diesel type. The aggregate represents something like 100,000 horsepower now used for marine purposes in large ships.

The subject of large oil engines for naval vessels is a live one, and has received the attention of all the principal European powers. Germany is experimenting with engines of 12,000 horsepower for battleships. France is doing likewise, England is building a number of large oil fuel carriers equipped with these engines. But, in point of size, the United States Government has selected the largest engine yet undertaken for a cargo vessel. In this way the Government is placing itself in a position to go ahead with still larger engines for naval vessels when the time arrives.

LAUNCH OF *H. M. S. Haughty.*—Messrs. Yarrow & Company, Ltd., Glasgow, launched recently the destroyer *Haughty,* 220 feet long, 27 feet 6 inches beam. The main engines consist of a two-shaft arrangement of Brown-Curtis turbines. Steam is supplied by three Yarrow boilers fitted with patent feed heating and superheating arrangements and designed for burning oil fuel exclusively.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XI

Engine Fittings

"As we look into the fittings which go on a boiler we should also pay some attention to what are known as engine fittings.

"The principal of these is the throttle valve, by means of which the engine is started or stopped at will. It is customary to bolt the throttle direct to the high-pressure valve chest, and to operate it by means of a lever and rods from the working platform. The most generally used type of throttle valve is known as the double-beat valve, the general principles of which are shown in Fig. 18.

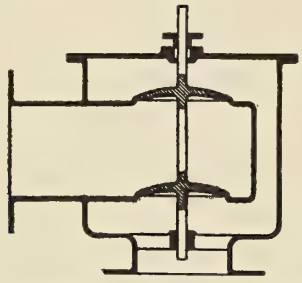


FIG. 18.—DOUBLE BEAT POPPET VALVE

"This is really two valves in one, the steam entering through two openings in the valve casing. The two disks are worked on one stem, the upper disk being made slightly larger than the lower one, so that the tendency is always to close the valve. However, this difference in the load on the two disks is so slight that it can readily be overcome by means of the throttle-working lever. This lever works on a notched quadrant, and it is held in position by means of a spring latch. In practical working of a throttle you will find that it only needs to be opened a very slight amount in order to work the engine 'to bells,' as it is termed.

"Right here it may be well to inform you that a valve does not have to be opened very far to secure a full opening, or to have it 'wide open,' as the term is. A little figuring will illustrate the idea. For example, if you are using a throttle 10 inches in diameter, its total area is 10 by 10 by .7854 = 78.54 square inches. That is, to find the area of a circle you multiply the diameter by itself, or square it, as the mathematicians would tell you, and then multiply that product by the constant .7854. To find the circumference of a circle you multiply the diameter by the constant 3.1416. This last constant is known as 'pi'; now don't be alarmed, O'Rourke, for that is not the kind you eat, it is simply the Greek letter that is selected to represent the ratio between the diameter and circumference of a circle. The circumference of a 10-inch circle is 31.416 inches. Dividing 78.54, the area in square inches, by the length of the circumference, 31.416 inches, you will find the answer to be 2.5. In other words, a 10-inch throttle valve has to be opened only 2½ inches to be wide open. You should also note that 2½ is just one-fourth of 10, and bearing in mind that the ratio between the circumference and diameter of all circles is the same, you will see that any valve has to be raised only a distance equal to one-quarter its diameter to be 'wide open.'

"Most valves are designed to allow a larger opening, but you will see from the illustration that it is not necessary to jam a valve open as far as it will go in order to get the full area through it."

"Isn't it possible to get a triple-expansion engine stuck on a center?" asked Pierce.

"Yes, it is not only possible but it occurs quite frequently," answered McAndrew. "To avoid trouble of this kind all compound and triple-expansion engines are fitted with what are termed 'pass-over valves.'"

"That must be a Jew valve!" suggested O'Rourke.

"This is hardly that kind of a valve," continued the instructor. "The necessity for such a valve occurs when the high-pressure crank is on the top or bottom center, a condition which generally arises at the most inopportune times, such as working the vessel into a dock. However, by quickly opening the pass-over valve, a small stop or slide valve, live steam is admitted into the intermediate valve chest, which starts the intermediate piston in motion and pulls the high-pressure crankpin over the center. The hand-wheel or lever for controlling the pass-over valve is always located at the working platform within convenient reach of the man operating the engine."

"Why are drain valves necessary?" asked Schmidt.

"Because steam when entering a cold cylinder or valve chest is condensed into water, which, if not allowed to drain off, would cause a water hammer and might break a cylinder head. Drain valves are located at the bottom of each valve chest and cylinder at the lowest points. Sometimes they are operated by means of an extension rod and a hand-wheel at the side of the cylinder, but more often by means of shafts and levers located close up to the working levers, so that the man operating the engine can open or close the drain from any cylinder without leaving his position.

"Relief valves are located on each valve chest and at the top and bottom of each cylinder. These are, in reality, small safety valves, similar to those used on boilers, and are for the purpose of automatically relieving any excess pressure, either of steam or water, mostly that caused by water, in the cylinders."

"What is the use of a turning engine?" inquired Nelson.

"That's easy," volunteered O'Rourke. "It's to keep us horny-handed sons of toil out in the fire-room from breaking our backs by jacking the old engine over every day!"

"Judging from some firemen I have had with me," replied McAndrew, looking straight at O'Rourke, "working the turning gear is about the only real work you can get out of them while the vessel is in port.

"Turning-engines are not usually fitted on engines of less than 3,000 horsepower, as it is much simpler to have the ordinary hand gear, which usually consists of a large worm-wheel secured to the crankshaft just aft of the engine bedplate; a small, vertical or inclined shaft pivoted at the bottom works the worm, which meshes with the main turning wheel, the shaft being operated by a ratchet lever. If steam power is used it is usual to drive the worm-wheel by means of one or two small cylinders, the whole apparatus being so geared that it takes hundreds of revolutions of the small engine to turn the main engine over once."

"Why do you have to turn the main engine over when steam is not on it?" asked Pierce.

"It is quite often necessary to do so when making adjustments to the crankpin brasses, in order to get the particular crank on the top center; sometimes it is necessary to jack the

* Engineer-in-Chief, U. S. Revenue Cutter Service.

main engine over while adjusting the valve gear. All engines in which metallic packing is used for the rods should be jacked at least once each day, in order to prevent rough places being formed on the polished rods from standing too long in contact with the packing at any particular point of the stroke.

"Leaving the main engine and looking aft, the first thing of importance we see is what is known as the 'thrust bearing,' a most important element in steam machinery, as it is by means of this piece of mechanism that all of the driving power of the propeller is transmitted to the ship itself.

"As the propeller revolves in the water it has the same tendency to advance that a screw has in a piece of wood, and it is this pushing effect, or thrust, as it is called, which, transmitted through the agency of the shafting and the thrust bearing, drives the ship along. This bearing therefore must be firmly secured to the hull of the ship, and must be so designed as not to become overheated on account of the necessarily large amount of friction on the bearing surfaces. That part of the shafting upon which the thrust bearing is located is known as the 'thrust shaft,' and it is usually made short in length in order to facilitate its removal from the ship when

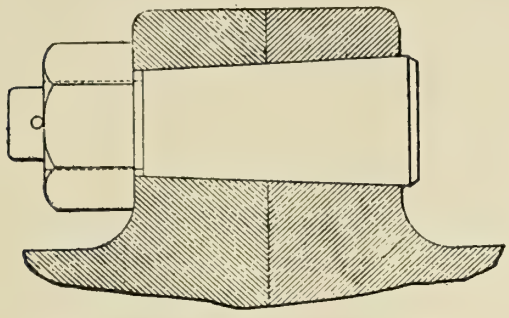


FIG. 19.—DETAIL OF FLANGE COUPLING AND BOLT

it becomes necessary, as may happen, that it has to be placed in a lathe for the purpose of removing the scores from the bearing surfaces. On this thrust shaft are a number of solid rings or collars, which fit between what are known as 'horseshoe collars,' and which are supported on rods on each side of the bearing, each being provided with two adjusting nuts on the rods, so that each individual horseshoe may be adjusted to bear a proportionate amount of the thrust of the shaft. The bearing faces of these collars are lined with white metal, so as to reduce the friction to a minimum. The bottom of the bearing usually forms a rectangular tank or trough, which is filled with oil so that the collars on the shaft revolve in it and carry the lubricant to the bearing surfaces. To keep the bearing cool it is customary to fit a flat coil of pipe in the bottom of the oil reservoir, and to connect this coil to the water circulating system. The best thrusts also have separate water pipe connections to each horseshoe collar. Too much attention cannot be given to the thrust bearing, for if it is not properly oiled and cooled a great deal of trouble can arise on account of excessive heating.

"Just aft of the thrust shaft, the main or 'line shafting' extends to what is known as the 'tail shaft,' the last portion of the propeller shafting. This line shafting is known as the intermediate shaft, and is made in one, two or three sections, according to the length of the vessel. All lengths of the shafting proper are made of the best quality of wrought steel, and they should be carefully forged and inspected, as the breaking of any part of this important connection between the main engine and the propeller totally cripples the ship if she is of the single-screw type. It is customary to connect the several sections of the shafting together by means of what are known as flanged couplings and tapered bolts, as shown in Fig. 19.

"The bolts are made tapered for convenience in backing them out whenever it becomes necessary to remove a section of the shaft.

"Each section of the intermediate shafting is usually supported on two bearings, which rest on suitable foundations of plates and angles built up from the frames of the ship. These bearings probably have more names than any other part of the steam machinery. Different people refer to them as 'spring bearings,' 'pillow blocks,' 'tunnel bearings,' 'steady bearings' and plain bearings. However, no matter what they are called their function is a very simple one, namely, that of supporting the weight of the shaft and keeping it in alinement. With such simple duties to perform, it is customary to fit the bottom with a brass, or to line it with white metal. The top of the bearing serves no other purpose than to keep the dirt out of it, and to support oil cups or compression cups containing grease for lubricating purposes.

"Inexperienced oilers, like O'Rourke will probably be, pay a great deal of attention to spring bearings, but the old timers give them a familiar slap in passing, as they know that bearings of this kind seldom give trouble from overheating.

"In single-screw vessels the tail shaft, or propeller shaft, passes through what is known as the 'stern tube,' a heavy cylindrical iron or steel casting extending from the after bulk-

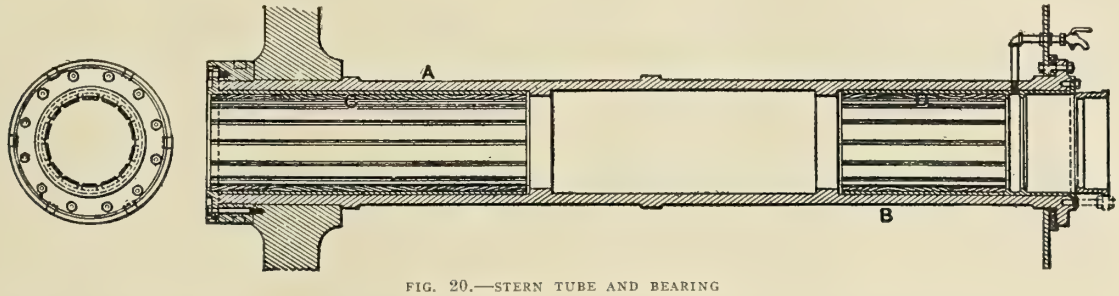


FIG. 20.—STERN TUBE AND BEARING

head of the shaft alley to the eye of the stern post. It is advisable, and also customary, to increase the diameter of the tail shaft over that of the intermediate shafting, as where it passes through the stern bearing it is not possible to inspect it often, and being constantly immersed in salt water it may become badly corroded. To provide against this corrosion the tail shaft is usually encased in composition sleeves shrunk on the shaft by heating the casing before it is slipped in place. By carefully soldering the ends and the joints between the sections of the casing, the water is usually kept out, but unless the soldering is well done the water is liable to leak in and cause havoc to the shaft.

"At the forward and after ends of the stern tube, bearings are formed of composition castings containing dovetailed grooves. In these grooves are strips of lignum-vitæ, a tropical wood and about the hardest that grows. The bearing surface should be on the end of the grain, and the strips should be well soaked in oil before being driven into place, as the water which circulates around the shaft is the only lubricant it receives. At the inboard end of the stern tube there is a

stuffing-box packed with square hemp or flax packing, a job which can only be attended to while the vessel is in the dry dock. There is usually fitted a small cock and a pipe leading to the water space, by means of which a small stream of water is allowed to trickle on the stuffing-box and its gland in order to keep them cool. This also allows a circulation of the water in the stern tube.

"In sandy or muddy water the lignum-vitæ in the bearings is found to cut out quickly, and in some vessels it is customary to fit a stuffing-box at the after end of the after bearing and to line the stern bearing with white metal. Lubrication is furnished to such a bearing by means of an oil cup or compression grease cup located above the waterline in an accessible position.

"Fig. 20 will show the usual form of stern tube, bearings, etc., used on single-screw vessels."

(To be continued.)

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Retarders for Tubes

The usual design of retarder is shown in Fig. 1, and consists of a steel rod round which steel wire is wound. This method involves considerable labor in the fitting, as unless the wire is very carefully wound a good lot of filing will be necessary before the apparatus is a good fit in the tube. The following method (Fig. 2), put into practice on some recent steamers, is cheaper and easier to produce. A steel bar of square cross-section is procured and ground so that it is an easy sliding fit in the tube. This bar is then heated and twisted into a spiral form, after which it can be fitted into the tube without much further trouble. In any case if it is a trifle too large it is much easier to touch up the corners with a file than to fit the other design of retarder. "ISON."

Glasgow.

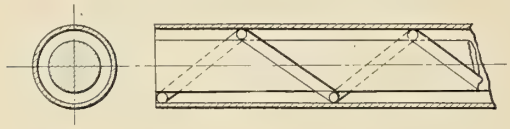


FIG. 1

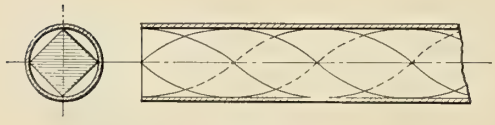
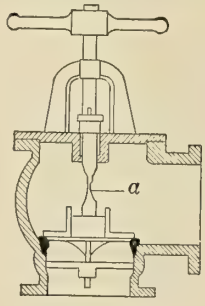


FIG. 2

Electrolysis

For two years when the vessel went for the annual docking, repairs and examinations, we had found the valve stem of the 16-inch suction valve from the engine room bilges to the centrifugal circulating pump (used to cool the condenser), as at *a* in the accompanying sketch. The first year it was considered that the stem had been made from a poor piece of metal (rolled composition), and a new piece of rolled material was procured and a new stem made. The ship was tested out for grounds to prevent electrolysis, and plenty of zinc was fastened to the valve and valve body, but at the next annual overhauling and docking it was found worse than before at the corroded part *a*. The diameter was less than a quarter inch, but the valve body was not corroded at all. The previous year the company had been notified of the facts, and the stem had been sent to show what electrolysis was doing to us. On being notified the second year that the stem had been found in the same condition, they suggested that we make a stem of cast brass. This was done, the zinc renewed, and we never had any more trouble from same. It dawned on me then that the body was not attacked on account of being cast brass, and on examining the metal in the stems for the injection and overboard discharge, it was found that they were made of cast brass, and they had never corroded. I am not stating that all valve stems that are surrounded with salt water should be made from cast brass, for ours may have been a peculiar case of electrolysis, for we all know that it is a mysterious thing at best, and does not always seem to attack metals in the same way; but from this experience, after trying the usual preventatives and not being successful, my next step would be if possible to change the composition, so that it would be like something near by which was not being attacked.

REPAIRS.



WASTED VALVE STEM

Quick Repairs on a Broken Valve Guide

A vessel equipped with a 5,500 horsepower engine of the inverted type was running about half speed in a heavy seaway when the valve guide, located aft of the low-pressure cylinder, broke. The crack started 4 inches from the top on the inboard side and ended 8 inches from the top on the outboard side. As the engine was stopped immediately, no harm was done to the valve gear. The valve crosshead carried two low-pressure piston valves, the guide was of the usual type bolted to the lower valve covers and projecting down through the center of the crosshead. When the engine was stopped, the part of the guide below the break fell down on the eccentric straps. The engine was in a helpless condition, and, as the vessel was in a heavy seaway, immediate repairs looked remote to me.

In this case a valve guide was certainly necessary to turn the engines over again, and I could see nothing else to do than to lay there and roll until we disconnected the low-pressure cylinder and compounded the engine. Altogether this was not

a nice job to undertake in such a seaway, for it would take at least two or three hours before the engines could be started again, but I was so sure that this was the *modus operandi* that I had the engine secured in the shortest possible time and commenced to get out the necessary wrenches, slings, falls, etc., to strip the low-pressure engine. Meanwhile a messenger was dispatched to the chief engineer's room to awaken him and inform him of the trouble, for this was 2.30 A. M. Such things, by the way, always seem to happen at night.

When the chief arrived in the engine room he looked at the broken guide on the floor plates and the part that remained in place, and then said: "Bring out a short jack and a hand saw." I thought that it might be possible that he was not quite awake yet, so I ventured the remark, "Is it a hack saw that you mean?" for I could not see anything that could be done with a wood saw nor with a hack saw either, as far as that is concerned; but, no, it was a wood saw that he wanted, and he said so with a few emphatic remarks.

In one of the bunkers we had some 8-inch by 8-inch and one piece of 12-inch by 12-inch yellow pine 10 feet long, which I had tried to put ashore before sailing, as it seemed like useless luggage, but I was told that it would not cost much to carry them, and so they stayed on board. We were told to get out the 12-inch by 12-inch piece and two pieces of the 8-inch by 8-inch. Then with a chain fall we pulled the broken piece back in position, sawed off two pieces of the 8-inch by 8-inch and set one piece on the forward bearing of the thrust block and the other piece on the top of the after main bearing. We then placed the 12-inch by 12-inch piece on top of them, resting the jack on the same and setting it up on a block that rested on the end of the broken guide. This held the lower end solid and the top end was held firmly by the ragged edges of the break in the cast iron, which fortunately was nearly flat. The corner of the 12-inch by 12-inch piece was cut off to let the guide head eccentric rod work up as close as possible. Two blocks were driven in between the uprights and engine frame. The outer ends were held in place with chain falls and the inner ends spiked.

The engine was started in just fifty-five minutes after the guide carried away, and the ship's head was put up to the gale again. The patch held until we reached port, where a new one was fitted. The only fault was that the engine could not be run quite in full gear, as the go-ahead eccentric rod had to be kept clear of the 12-inch by 12-inch cross piece.

A READER.

Marine Engineering in the Good Old Days

Thirty years ago the writer began his career as a marine engineer by shipping as oiler on a coasting steamer. This was a screw-propelled, wooden vessel of about 1,000 gross tons, fitted with a single engine, 40 inches diameter of cylinder and 42 inches stroke of piston, with hook motion and jet condenser. Steam was supplied from a three-furnace Scotch boiler carrying 30 pounds steam pressure. It is difficult for a young engineer, trained on a modern steamship, to realize the advance that has been made in engineering since that time.

On this ship nothing but soft packing was used in piston rod and valve stem stuffing-boxes. Pumps were all packed with hemp packing laid up by hand, and it was no mean job to lay up the different sizes of packing used—4, 8, 12 and up to 24 strands. Compare this with the machine-laid packing used to-day.

Common rubber was used for joints almost exclusively. It was considered quite an advance in joint packing when we got Usidurian. And how many different ways there were of handling this. One engineer would not allow a wrench used on a joint while it was hot, but would wait until the trip was ended and the joint cooled off before taking up on it. Of course, a joint blew out occasionally, but he considered this one of the fortunes of war. The question comes as to what he would do with it in these days of high steam pressure.

On the ship above mentioned common lamp wick, soaked in white or red lead paint, was run around the cylinder flange, inside of the studs, for a cylinder head joint, and when an asbestos joint was proposed the chief engineer protested on the grounds of excessive expense.

It was the practice of engine builders up to about that period to make the journals, particularly the crosshead guides, as small as possible to reduce friction, they considering that the more square inches of wearing surface the more friction. We now know that the pounds friction on a journal is a fixed quantity, and the larger the journal the less friction there is per square inch, therefore the easier working journal. All kinds of lubricating compounds were used on journals in those days, varying according to the ideas of the engineer in charge. Lard oil was the common lubricant, mineral machine oil being a later development, and this would be mixed with tallow and plumbago or black lead, sometimes white lead or softsoap, to use on a journal that was subject to chronic overheating.

The use of tallow for cylinder lubrication was just about abandoned then, mineral oil being substituted, although some of the then old-time engineers had serious doubts about mineral oil being able to lubricate anything, unless it was the oil salesman's tongue. Sight-feed cylinder cups for feeding oil to the cylinder were in their infancy, and all sorts of ideas were rampant as to the proper method of attaching them. Some engineers contended that they would not work without a large reservoir for water in the pressure pipe; others that the pressure pipe must be led direct from the boiler, and considerable ingenuity was displayed by all in keeping the body of the oil cup warm and the water reservoir cool.

No engineer in those days believed that a boiler would deliver dry steam without a capacious steam dome or chimney, yet even with these the boilers of that period were notorious for their foaming proclivities. A common remedy for this at that time was the injection of about a quart of fish oil through the feed pump, a small connection being attached to the suction side of the pumps for this express purpose. Imagine doing this to-day with our high steam pressure, surface condenser-fed boilers! With the old low steam boilers fed with salt water from a jet condenser, grease in a boiler was not much of a factor.

What a job there was scaling boilers each trip, and what a variety of tools was devised for the removal of the scale! About the only boiler compound in general use then was common kerosene (paraffin), or coal oil, as it was called, and the writer knows from experience that it would "accomplish that purpose whereunto it was sent"—that of penetrating the scale. Of course, it sometimes penetrated through the tube sheets around the tubes, causing them to leak, but that was also a fortune of war. A case of another boiler compound that came under the writer's notice was where a cargo of molasses in hogsheads leaked into the bilges, and it became necessary to use the bilge injection to keep the ship free of water. The boiler was fed from this water, and when it was opened all the scale had fallen off the tube sheets and furnaces to the bottom of the boiler. What effect the continued use of molasses as a boiler compound would have on the boiler itself remains in doubt.

Independent pumps of that date were mostly of the crank and fly-wheel type, there being a few of the direct-acting type, but not then in common use. These pumps took up a large portion of the engine room space and were usually placed in some inaccessible corner, so that it was necessary to stand on your head to pack the water end, which with the hand-laid packing used had to be done frequently.

Air pumps were all attached to the crosshead, and were fitted with single valves, one suction, one bucket and one

delivery valve. These were made of soft rubber, and would swell up to twice their original thickness after a couple of months' use, becoming soft and flabby and then tearing. Few of these valves had a straight lift, but were fastened in the middle and curled up at the circumference around a convex guard. Fortunately, the water delivered from the jet condenser was not very hot, so that this style of valve answered the purpose.

In one particular the practice of that period was superior to the practice of the present time, and that was in the complement of the engine room force. On the ship mentioned in the beginning of this article two engineers, two oilers, three firemen and two coal-passers were carried. The writer was chief engineer of a coast towing steamer of nearly 700 gross tons in late years, on which exactly the same complement of engine room force was carried. In the first vessel the only auxiliaries were two hoisting engines on deck and a donkey pump in the engine room; while the last one mentioned had as auxiliaries a donkey pump, sanitary pump, wrecking pump, independent feed pump, circulating pump, electric light engine, steam steering engine, steam capstan, steam windlass and steam towing engine, in addition to having triple-expansion engines, as against the single engine and two boilers as against one. It can readily be seen that even with the same lay time in port there was considerably more work to be done to take care of the modern vessel than the older one. When we stop to consider that this older vessel was only under way about 80 hours in a week, while the later one only stopped about 6 hours a week on an average, it may be taken for granted that marine engineering thirty years ago was not the strenuous occupation it is to-day.

More and more is being demanded of the marine engineer. In a modern ship the engineer is called on to furnish the light, heat, power for steering the ship and getting the anchor, power for getting the cargo in and out and hauling the ship around the docks, keep the lavatories and the steam tables and boilers in the kitchen and pantries in working order, and many other details in addition to propelling the vessel, and while wages have advanced some during the period treated of in this article, they have not advanced commensurate with the extra labor and skill demanded, not to speak of the increased cost of living, which affects the marine engineer and his family in common with all classes of working men.

It is to the credit of the marine engineer that his intelligence and capabilities have equaled the demands; in the old days they fulfilled all requirements, to-day they do the same.

J. S.

[The old vessels referred to in this article are not to be understood as being ships built or building thirty years ago, but ships built previous to that time and in operation then.]

The Education of a Young Mechanical Engineer

Of late years much has been said, and many plans have been devised, for the education of the young men who are required to take the place of the "Old School" engineers, who are gradually giving way to the college-trained men. Some of these plans are excellent in their make-up, but incur many difficulties and inconveniences on account of their arrangement, and the amount of trust put in a school boy. This is wrong, as I will explain further on.

Many prominent engineers have suggested sending the young men to college directly they have finished at the grammar school without a preliminary knowledge of practical engineering, but this I consider to be a great mistake. If the above course is followed, the youth goes to college feeling very important, but forgets the real reason for which he went. When a professor commences to lecture on glands and stuffing boxes, he is lost, and the subject holds little interest for him afterwards; so what does he do? Well, he will say to a few friends, "Prof. Witt is lecturing on packings to-day, so let us slack." This he does, and, unfortunately, the longer he is at college the more frequent it becomes, naturally with a disastrous ending to his education. It is not that the education is inadequate. No! not by any means, but because the student cannot get interested in what is being said. He is inclined to give too much time to sport and pleasure, simply because he knows practically nothing about the simple steam engine and workshop practice. Now, again, if the same youth goes into the workshop during the summer vacation, he is looked upon by the foreman as one who is to do as little as possible because he has been to college, with the result that his hands are in his pockets most of the day; therefore he gets fed up with what he has not to do, the interest is lost, and all he wishes for is 5 P. M. Now, such a state of affairs is detrimental to the youth, and his education suffers accordingly.

What is wanted to-day is a practical man theoretically trained. The question might be asked, How is the young man going to get the necessary training? Well, a building won't stand without a good foundation; so the same with a youth. Give him a good foundation and he will make good. Now the only way he can acquire this is to go to the shops for four years, after having passed through the grammar school. When he has been there a few years he realizes the meaning of the word "responsibility," and so, when he eventually goes to college, he is a man and understands the full value of the education he is still to obtain. His mind is filled with one thought: "I am here for a purpose, and that is to become an engineer." So, with this thought constantly in mind, he sets to and works for something tangible. After such a long time in the shops he is sure to find a difficulty with mathematics at first, but at the present time mathematical classes are so arranged at the technical colleges to suit the ability of the student, and with a little hard work this difficulty can be mastered. His thoughts are not so easily diverted from his study as the youth who has come direct from school to college, and he is better prepared for hard work and concentration; he can follow his professors' lectures and knows how to apply them in practice. The other youth considers his college life to be a time for pleasure, as he believes it soon enough to work after he gets out into the world, but I think it is recognized that the time to learn is when one is young. This might not be the case with all, but I should certainly put it at about 80 percent.

Having mentioned the aforesaid, I will take the liberty of putting forward a course of training which I consider adequate for a youth who intends to become a mechanical engineer.

The boy should be kept at school until he is 15 or 16 years old. He is then sent to the shops for four years (a small shop being advisable for the first three years, with the fourth devoted to erecting work in a large engineering works, where an insight into large constructional work may be had). During this period he should attend night classes, and so keep up his mathematics. Whenever possible, every opportunity should be taken of seeing machines and engines in motion and inquiries should be made as to the up-keep. Finding the best way to facilitate matters for the man that has to attend to the job always gives place for a little more thought. Just before the end of his apprenticeship he should sit for his matriculation. After passing, he should go to a good college and study for his B. Sc.; his summer vacation should be spent in the drawing office of a large engineering firm, not that he would expect to get the best of work, but to give him an insight into the running and managing of such an office, the reading and marking up of drawings, etc., because drawing office experience is certainly of the utmost importance to all engineers.

If such a course of training and educating was carried out,

I am sure there would be little fear about securing adequate men to fill the places of the retiring "Old School."

JAMES CARNEGIE, JR.

Loss of Vacuum in Dredging Pumps

A partial loss of vacuum in one of the main pumps on a large dredger in which I did duty as first assistant engineer, gave us on one occasion a fair measure of food for thought, as well as much unnecessary hammer and chisel work, before we discovered the cause, simple enough though it proved to be in the end.

The pump in question had a 7-foot impeller, and was driven by a triple-expansion engine capable of developing 1,500 horsepower. Under ordinary working conditions our gages indicated 27 to 28 inches of vacuum, but at the time of which I write a gradual decrease in the vacuum indicated on our port pump became noticeable. We tested our gage, examined the impeller and its portable throat piece, and, of course, made sure that no leakage of air was taking place at the impeller shaft glands or suction pipe joints; but our gage was found correct, the pump in perfect working order, and all glands, etc., quite air-tight.

With regard to leakage of air into a suction pipe, and the effect of such leakage on a well-designed centrifugal pump, it may be interesting to note the result of an experiment made while we were busy trying to solve the problem set us by our port pump. In the suction pipe, and at a short distance from the impeller casing, we drilled a hole 1 inch in diameter, fitted a wooden plug into this hole and started our pump. When the vacuum had reached its apparent limit the plug was withdrawn, but though the inrush of air was very considerable the effect was scarcely, if at all, noticeable on the vacuum gage. From this we inferred that the efficiency of our centrifugal pumps could not be seriously impaired by a leakage of air in such a volume as might seriously affect the working of an ordinary pump.

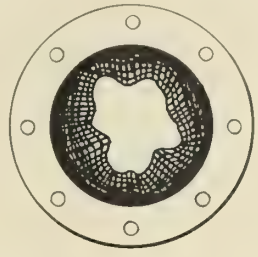
The cause of our perplexity was still to be found, however, but find it we did; and not in the suction but on the discharge side of our equipment, and in the flexible sleeve whereby connection was made to the floating pipe line which conveyed our spoil to the shallows over which it was distributed. The sleeve in question was made of stout leather, double-ply, held together by copper rivets, and protected on the outside by a kind of chain mail covering. When, in the course of a diligent search for several missing inches of vacuum this sleeve was disconnected, its inside presented the curious picture shown in the sketch. The inner ply of leather was worn away at places where it had probably been kinked, and the opening thus made had formed the mouth of a concentric bag, so to speak, which, filling up with mud and sand, reduced the actual area of discharge to such an extent that "throttling" took place, with the result that a back pressure was formed in the impeller casing, with a corresponding loss of pumping power, of which the first indication was given by our vacuum gage.

In this case the remedy for the difficulty was, of course, the fitting of a new sleeve.

When next I saw a similar problem present itself for solution it was on another hydraulic dredger of the hopper and overboard discharge type—that is to say, we could fill our hoppers and pump the contents on shore, or dump them through the bottom; or we could dredge and discharge the spoil direct into a floating pipe line, or across a levee, without putting any into our hoppers.

On this occasion the loss of vacuum again indicated a block in the discharge pipes; the block being caused by the *debris* (bits of rope, old matting, and many of the curious odds and ends to be found at the bottom of one of the busiest river ports in China) which from time to time fouled the isolating valves in the discharge pipes leading to the hoppers. These valves were of the "butterfly" type, and the difficulty was this time overcome by their removal altogether, ordinary flap valves with suitable closing gear being fitted instead to the ends of the discharge pipes where they led into the hoppers.

I may say that in the second instance referred to the



EXTENT OF ACCUMULATION IN SLEEVE

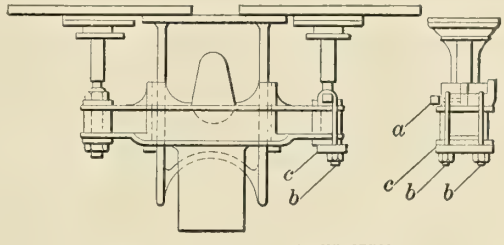
vacuum gages were fitted on the air chambers with which our suction pipes were provided. In the first instance mentioned the gages were fitted to the impeller casing, and there were no air chambers on the suction pipes.

MARK NESBIT.

Repairing a Broken Valve Stem

A broken valve stem would seem like rather a serious thing to most of us and it would be likely to interrupt things for a while. It is a little out of the ordinary therefore to have one snap and be under way again in thirty minutes.

At 10:30 one morning our outboard A. L. P. valve stem broke just at the top of the yoke. The engine was stopped; a dog brought from the machine shop and secured to the broken



REPAIRS TO BROKEN VALVE STEM

stem with a set screw in dog (*a*) after cutting a place in the stem for the end of the set screw. While this was going on two bolts (*b*) were having hook ends bent on them in the fireroom, and a strap (*c*) was drilled to go on the bottom of the yoke through which the bolts were to go. The other ends of the bolts were to go over the dog, one at the set-screw end and the other at the tail end, as shown in the sketch.

In just thirty minutes from the time of the break we were going ahead again, and for several days the arrangement held until we reached port and replaced the broken valve stem with a new one.

READER.

Freight Train Collides with Steamboat

An extraordinary event was recorded recently in the St. Louis newspapers, in which a railway train collided with a steamboat, both the train and the steamer remaining on their natural element. The collision took place during the floods that devastated the Ohio Valley during the early spring. The small steamer *Lochie S.*, in proceeding up the Ohio Valley along the Cumberland River, then at its greatest flood height (covering the low lands and submerging the tracks of the Louisville & Nashville Railroad), made her way far from the usual river channel and crossed the railroad tracks just in time to meet a freight train, when, owing to darkness and a misunderstanding of signals, the railroad locomotive plowed into the starboard side of the steamer, temporarily suspending traffic at that point.

H. M. BAKER.

St. Louis, Mo.

Marine Articles in the Engineering Press

Steam Trials of H. M. Battle-Cruiser Queen Mary.—Built by Palmer's Shipbuilding & Iron Company, at Jarrow-on-Tyne, and engined by Messrs. John Brown & Company, Ltd., of Clydebank, the battle cruiser *Queen Mary,* which is 660 feet long, 89 feet beam, with a displacement of 27,000 tons at a draft of 28 feet, showed most satisfactory results in the various trials which were carried out recently. The main engines comprise a four-shaft arrangement of Parsons turbines, designed to develop 75,000 horsepower, a figure which was exceeded by 10 percent on trial. 350 words.—*Engineering,* June 6.

H. M. Torpedo-Boat Destroyers Shark, Sparrowhawk and *Spitfire.*—These vessels form a group of three of the twenty British destroyers designed by Sir Phillip Watts, K. C. B., when director of naval construction at the Admiralty and built in various establishments under the 1911-12 programme. The hulls of these three vessels were constructed by Messrs. Swan, Hunter & Wigham Richardson, Ltd., and the propelling machinery by the Wallsend Slipway & Engineering Company, Ltd., Wallsend-on-Tyne. The vessels are 260 feet long, 27 feet beam, 9 feet 4 inches draft, with a displacement of 935 tons, of which the hull weights comprise 373 tons. Designed to steam at full speed in a heavy sea, they are provided with an exceptionally high forecastle, the conning tower and bridge being located directly behind the after end of the forecastle. The armament includes three 4-inch guns and two torpedo launching tubes, one amidships and one aft. The propelling machinery consists of a twin screw arrangement of Parsons turbines, each turbine having ahead-going and astern sections incorporated in the same casing. An impulse wheel with special blading is fitted to both the ahead and astern turbines to deal with the highest pressure steam which is admitted through groups of nozzles, each group having a controlling valve. After leaving the impulse wheels the steam is further expanded through a number of stages fitted with the usual reaction blading of the Parsons type. The engines of each destroyer were designed to develop 24,500 shaft horsepower in order to give a speed of 29 knots. On trial all of the three vessels on the six runs over the measured mile, made in rough weather in each case, attained a speed of about 30¾ knots, with an average mean shaft horsepower of about 25,400 at 635 revolutions. This power was maintained for eight hours in all three vessels, with an oil consumption of about 1 pound per shaft horsepower per hour. Details of the boilers and auxiliaries are included in the article. Two illustrations. 1,000 words.—*Engineering,* June 6.

Misconceptions of Propeller Action.—In an editorial discussion, pointing out a number of erroneous assumptions which form the basis for many of the proposals which are so frequently made by theorists in attempts to improve the efficiency of the screw propeller, the conclusion is reached that a screw propeller having a driving face of truly helical shape, a symmetrical section of blade, a diameter and area of blades correctly apportioned to the work to be done and a boss as small as possible, will be the most efficient instrument for screw propulsion. Among the fallacies discussed were the following: That the blade surface of a propeller should have a progressively increasing pitch in the axial direction from the leading to the following edge instead of having a truly helical shape; that a gain in efficiency can be obtained by propellers with blades having a section which has both the driving face and the back of the blade curved, so that the metal shall be symmetrically disposed on each side of the line joining the following and leading edges, which line will then be the real pitch line of the propeller; that centrifugal action at the propeller causes water to be thrown off radially at the tips, thus dispersing it in other directions than the sternward one desired and absorbing energy which is lost as propelling force; that water near the center of a propeller does not contribute adequately to thrust because of a churning action at the root of the blade, and also that some other shape of blade section than that most commonly adopted would reduce the resistance of the propeller to rotation. While these fallacies are pointed out, it is also conceded that it is possible that a gain could be effected if the propeller were divided transversely into two parts—one right-handed and the other left-handed—turning in opposite directions as in torpedoes, so that the spiral action imparted to the water by the forward half would be neutralized by that from the after portion, and the momentum would be imparted to the water in a more directly sternward direction than is now possible. This, however, for the most part, has proved impractical, as it involves concentric shafting revolving in opposite directions. 1,600 words.—*The Engineer,* May 30.

An Armored and Semi-Submersible Destroyer.—By Hector C. Bywater and Maurice Prendergast. In the November, 1911, issue of the *Morskoi Sbornik,* the leading Russian naval review, there was published a design and a description of a proposed torpedo boat destroyer which had certain novel features. This article gives the main particulars of this design and comments upon the feasibility of such a type of vessel. The main feature of this design is the provision of armored protection on the destroyer strong enough to enable the vessel to withstand the attack of quick-firing guns up to 6-inch caliber. The only armor used on the destroyer is a protective deck, which covers the vital parts of the hull and extends 7 inches below the load waterline. To eliminate the danger of shells striking beneath the armor, provision is made for submerging the boat 19¾ inches deeper than the normal load waterline before going into action. In the design suggested the boat is 243 feet long, 28 feet beam, 6.2 feet draft, 620 tons displacement, with engines of 11,000 horsepower, designed to give a speed of 30 knots. In order to submerge the boat 19¾ inches, 225 tons of ballast are necessary, and this is provided by flooding certain of the watertight compartments. The deck armor is 2½ inches thick where it slopes to the waterline, and the boat is armed with eight submerged torpedo tubes, two 4.7-inch quick-firing guns and four machine guns. The design is criticised by the authors of the article in that it does not suggest either habitability or seaworthiness, and that the power seems inadequate for the expected speed. It is admitted, however, that the conception presents a wide field of possible development, as the application of armor to high-speed ships is a feature that will become general at no very distant date. 5 illustrations. 3,100 words.—*The Shipbuilder,* June.

The John Samuel White Diesel Engine.—John Samuel White & Company, Ltd., the well-known destroyer builders, of Cowes, I. W., have now built some half dozen Diesel engines under license from the M. A. N. This firm has adopted the two-cycle M. A. N. engine, and the details of their product apparently differ little from the original M. A. N. engine. The article gives a detailed description of the construction and operation of this engine, citing the trials with a 150-horsepower engine as an example. 3 illustrations. 5,500 words.—*The Engineer,* June 6.

Resistance of Submarines when Submerged.—The factors which affect the submerged resistance at any speed of a particular submarine, the general hull proportions of which are fixed, may be broadly summed up in three groups—surface

friction, depth of submersion and number and form of appendages. Surface friction resistance depends wholly upon the superficial area of the vessel for any particular speed, and is not affected in any way by change in the depth of submersion. With the same submarine run at different depths eddy-making will also be practically constant, so all the change of resistance which is measured may be attributed to variation of wave-making resistance with variation of submersion. Reference is made to the paper read at Rome before the first National Congress of Engineers by Capt. Leonardo Fea, describing experiments made on submarine models at Spezia, which give valuable information on the second and third factors considered. 1,400 words.—*The Engineer,* May 16.

The Passenger and Cargo Steamer Digby.—Messrs. Irvings' Shipbuilding & Dry Docks Company, Ltd., West Hartlepool, has built to the order of Messrs. Furness, Withy & Company, Ltd., the single screw passenger and cargo steamer *Digby,* designed for the owners' passenger, fruit and general cargo trade between Halifax, N. S., and Liverpool or London. The vessel is 365 feet long, 350 feet between perpendiculars, 50 feet extreme breadth, 25 feet 6 inches molded depth to upper deck. The hull is provided with a cellular double bottom, and is further subdivided by six transverse bulkheads. An elaborate system of mechanical ventilation has been fitted to the holds and 'tween decks throughout. Accommodations are provided for fifty-eight first class and thirty-two second class passengers. The propelling machinery, supplied by Messrs. Richardsons, Westgarth & Company, Ltd., of Hartlepool, consists of a set of triple expansion reciprocating engines with cylinders 28 inches, 46 inches and 77 inches diameter by 48 inches stroke. Steam is supplied by three single-ended boilers, each 16 feet 6 inches diameter by 12 feet long, working at 180 pounds pressure under Howden's forced draft. The designed speed is 12½ knots and the mean trial speed for four runs on the measured mile was 14.38 knots. 5 illustrations. 1,150 words.—*The Shipbuilder,* June.

The New York Pier Problem.—An elaborate series of towing experiments was carried out by Naval Constructor D. W. Taylor in the experimental tank at the navy yard, Washington, to study the problems involved by the various proposed pier encroachments on the shore lines of the Hudson River, where practically all of the large transatlantic express steamers are now berthed. The tank was arranged to simulate upon a proper scale a section of the river in question with its flanking piers, and models of the craft which ply in these waters were towed under various conditions to determine the suction effect exerted upon vessels moored at flanking piers when a large liner approaches or leaves a dock in a strong tideway, as well as the influences upon nearby shipping in motion. In the trials the model ocean steamship was progressively towed closer and closer to the pier heads and at varying speeds, duplicating the circumstances of slack tide and the conditions of ebb and flood at full swing. While the results from these experiments have not as yet been disclosed, it is intimated that these experiments confirm the earlier researches upon suction between ships made by Naval Constructor Taylor a few years ago, and they also clearly demonstrate that the size and draft of great liners materially effect the measure of the disturbances aroused, and these must be given their proper weight in considering the dock problem of any port where the waters are confined and where tidal velocities are of importance. 2 illustrations. 3,250 words.—*The Engineer,* May 16.

H. M. S. King George V.—The *King George V* and her three sister ships *Ajax, Audacious* and *Centurion,* all of the *Orion* class, represent a distinct advance over their predecessors. *King George V* is 555 feet long, 89 feet beam, 27 feet 6 inches draft with a corresponding displacement of 23,600 tons, or 1,100 tons more than the *Orion.* Propulsion is by Parsons turbines of 31,000 horsepower, supplied with steam from Babcock & Wilcox boilers. The normal fuel supply is 900 tons, and the maximum, with an additional supply of oil, 2,700 tons. The designed speed is 21 knots. The main armament consists of ten 13.5-inch guns, arranged in five turrets on the center line of the ship, using projectiles of 1,400 pounds. The secondary battery, which consists of sixteen 4-inch guns, is severely criticised in this article as being inadequate for repelling torpedo attack. *King George V* is protected amidships for about 250 feet by 11 to 12-inch armor, reduced to 7¾ inches below the end turrets and tapering to 4 inches fore and aft, leaving a space of about 30 feet unprotected at the bow and stern. Above the main belt is a strake of 9¾-inch armor, which extends from the base of the first turret to the base of the aftermost turret. 1 illustration. 930 words.—*The Marine Engineer and Naval Architect,* June, 1913.

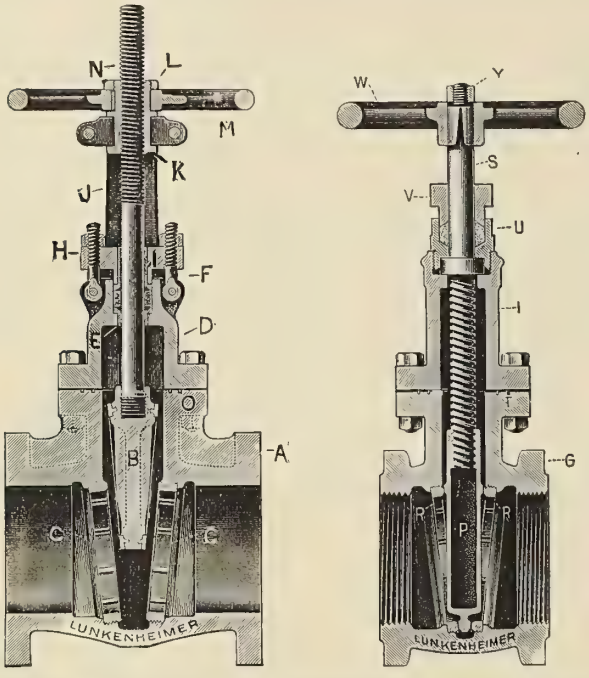
Steam Trials of H. M. S. Ajax.—On the trials of the battleship *Ajax,* with the turbines running at an average of 289 revolutions, the shaft horsepower was 19,830 and the consumption of coal 1.79 pounds. On the eight hour full power trial the average revolutions of the four shafts were 330, the total shaft horsepower just over 28,000, the average speed over 21 knots, and the coal consumption 1.69 pounds per shaft horsepower per hour. 500 words.—*Engineering,* May 30.

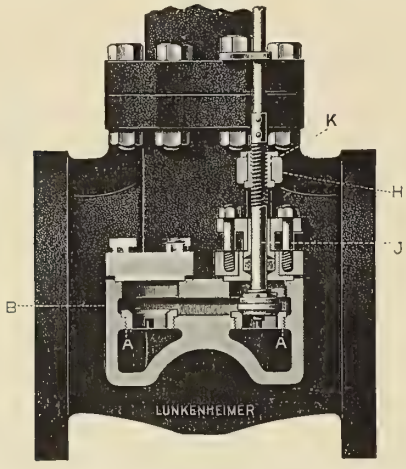
The Yarrow Boiler.—Tests were made recently on an improved Yarrow boiler having 4,440 square feet of heating surface, 93.9 square feet of grate area and a combustion space of 610 cubic feet capacity, which is similar to the boilers constructed for the Chilian battleship *Almirante Latorre,* now being built at the Elswick Works of Sir W. G. Armstrong, Whitworth & Company, Ltd. One of the improvements in the boiler consisted in placing angle-iron baffles on the outside rows of tubes to equalize the volume of the furnace gases passing through the nest of tubes, and to equalize the temperature of the gases as they pass the last row of tubes of the tube nest, thereby securing a high efficiency. Another improvement consisted in modifying the original feed water heater used in this type of boiler. The original feed heater was constructed by dividing off a certain number of the outer rows of tubes by partitions in the water pockets and passing the feed into the space thus divided off, so that the feed water would pass up through the two or three rows of tubes furthest from the furnace before it mixed with the general circulation of the boiler. This method of feed heating has been found to result in an economy of from 5 to 7 percent, but a further improvement was introduced by fitting a longitudinal plate on each side of the steam chest, so as to partition off the feed heating tubes where the feed enters the steam chest, in order to prevent the cooler feed water from rushing down the adjoining rows of tubes and alternately cooling and heating the plates and joints of the water pockets, and thereby producing excessive strains and causing serious leakage with a risk of cracking the plates. From the tests made it was shown that the gain by adopting the Yarrow system of feed heating was an increase in evaporation per pound of oil of 6 percent and a reduction in the temperature of the gases of 24 percent. The figures show that higher evaporation is possible with oil fuel as compared with coal, and the great advantage of the baffling arrangement as well as of the use of the outer tubes for heating the feed. Having in view the evaporation obtained with the most recent type of Yarrow boiler in combination with the latest type of turbine, the conclusion is reached that one shaft horsepower can be obtained from .9 pound of oil fuel, and if superheating be adopted a gain of 10 percent for every 100 degrees F., is secured. From experiments made by Messrs. Yarrow, this amount of superheat is easily obtainable in marine practice, and it is not unreasonable to expect that with 200 degrees F. of superheat it will be possible to obtain one shaft horsepower from 7½ pounds of oil fuel under naval conditions. 2 illustrations. 1,500 words.—*Engineering,* May 15.

ENGINEERING SPECIALTIES

An Improved Gate Valve

The improved gate valve illustrated herewith, which is manufactured by the Lunkenheimer Company, Cincinnati, Ohio, is made either entirely of brass or iron body, brass mounted, or in "puddled" semi-steel, and also cast steel. It is also made in practically all sizes and patterns and for all pressures and temperatures for which such valves are necessary. As can be seen from the illustrations the valves are made in two forms, one with a stationary stem and the other with outside screw and yoke. The seat rings, as well as the wedge disk, can be removed when worn, thus making the valve as





good as new. A very desirable feature in the construction of the valves is the fact that when finishing the interior of the valve body, that portion which receives the seat rings is threaded to the correct angle of the tapers of the valve disk. The seat rings are threaded and faced off straight, and when screwed in place they fit accurately to the tapers of the disk. This consequently makes it possible to easily renew the seat rings when they become worn or broken, hence prolonging the life of the valve. As the valves are double-seated they will take pressure from either side. Either pattern of the gate valve can be packed under pressure when wide open. The stuffing-box in the valve with stationary stem is made of bronze and is tightly screwed into the hub. In the valves with outside screw and yoke, both the gland and stuffing-box are lined with bronze bushings, which form a perfect bearing surface for the stems. The disks are accurately guided in the bodies, and by means of the guides the stems are relieved of all side strains. It is claimed that the valves are not affected to any extent by expansion or contraction. The joint between the body and hub is worthy of attention, for the reason that it is practically indestructible. It consists of grooves cut in the top surface of the valve body, in which are placed seamless copper gaskets. A joint made in this manner, it is claimed, will never leak and cannot wear out.

The valve can also be had with an exterior by-pass, a detailed view of which is also shown herewith. The by-pass used on the Lunkenheimer "Victor" valves is not separate from the valve proper but is cast integral with the body. The additional metal required for the by-pass tends to strengthen the valve body, and being self-contained it is not affected by extremes of expansion or contraction. The stuffing-box is made of bronze, and has a flange on the bottom, which prevents the iron flange above it from touching the iron body, and hence prevents the corrosion between these surfaces. Referring to the illustration, the outside screw and yoke *H* increases the durability of the thread on the stem *J*, owing to the fact that they do not come in contact with steam. The bushing *K*, which is threaded to receive the threads of the stem *J*, not only prevents corrosion but also makes it possible to renew the same should the threads become worn. The areas of the by-passes of these valves are sufficiently large to admit enough steam around the disk to quickly equalize the pressure on both sides.

Winton Marine Engines

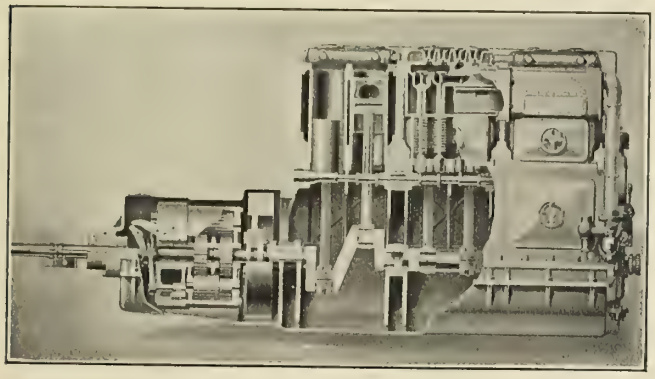
The Winton Gas Engine & Manufacturing Company, Cleveland, Ohio, has recently placed on the market an internal-combustion engine, known as the Winton Six Marine Engine, designed for all classes of marine service, such as high-class yachts, towboats and commercial motor boats. In the design of these engines all manifolds, piping and fittings that are usually found on marine motors have been eliminated and all the working parts have been enclosed, yet in such a way that they can be inspected immediately. The flywheel is removed from the front of the motor and housed at the after end, where it absorbs the strain from the propeller and shafting. The position of this wheel also eliminates the element of danger to the operator. Ample proportions of the working parts, together with the weight of the motor located where it should be to take the jar and explosive strains, it is claimed, eliminate vibration.

Chrome vanadium steel, heat treated and of ample proportions, is found in all the working parts which are subject to heavy working strains. The cylinders and pistons are of the very best close grained cast iron obtainable, heat treated, and even the small gears and pinions are hardened and tempered in oil and are of a high grade steel. There is not a single cast iron gear in the whole machine. The cylinders, pistons, cam shafts and all other bearing surfaces are ground by special machinery, constructed for the purpose. The connecting rods are drop forgings of .35 to .40 carbon steel, heat treated. The piston end is provided with a tool steel wrist-pin, which actuates on phosphor bronze bushings in the piston. The crankshaft end is machined to receive a die-cast bushing of white brass. The crankshaft and connecting rod bearings are of Parsons white brass and all others of phosphor bronze.

Oil is carried in the engine base and distributed under pressure by a geared pump to every working part and afterwards filtered for use again. Ignition is by the Bosch low tension system, using magnetic make-and-break plugs. Reversing is obtained by special spur gearing of Winton design. Both

gears and shafts are of integral forgings of chrome vanadium steel, heat treated.

One feature of this engine, which contributes to the steadiness of construction and does away with the piping and gear usually so prominent in marine engines, is the arrangement of the water, fuel and exhaust manifolds, which are of generous size and are integral with the cylinder castings. The cam shaft drive is obtained by a vertical jack shaft through worm spirals, which it is claimed gives a silent drive. The valve action is entirely housed and absolutely quiet. This is an exclusive feature of the Winton marine engine, which is



obtained through special cam millers designed and built by the manufacturers for this particular purpose. A centrifugal pump driven from the crankshaft with independent connections in the cylinder heads, with valves for regulating the volume, provides the water circulation. Control is obtained by a centrifugal governor operating at a constant mixture, volume throttling principle, so that any speed may be had by adjustment of this governor control.

Six cylinder engines rated at 60 to 75 horsepower, with cylinders 6½ inches diameter by 9 inches stroke, operating at 400 to 500 revolutions per minute, weigh 5,000 pounds, while six cylinder engines of 150 to 200 horsepower, with cylinders 9 inches in diameter by 14 inches stroke, operating at 350 to 425 revolutions per minute, weigh 1,500 pounds.

An Improved Process for Making Corrugated Tubes

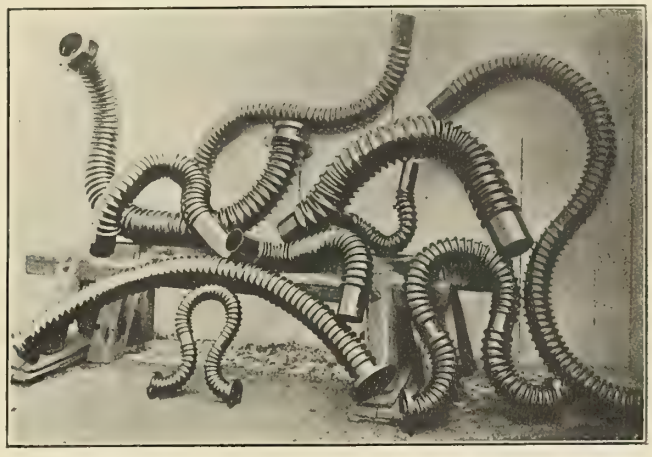
The term corrugated tubes is not new. Under this name tubes manufactured by various methods have been brought out from time to time with more or less success. Recently a process of manufacture has been patented which, on account of the excellent results secured, has been adopted for many purposes. The process has been patented in the United States and Europe by Mr. W. Maciejewski, a Polish engineer. The European patents have already been purchased and corrugated tubes made according to them by the following companies: Russia, "Compensator" Works, W. Maciejewski, Warsaw, Polna 36; Germany, Franz Seiffert & Company, Act. Ges., Berlin, SO 33; Belgium, Anciens Etablissements Louis De Naeyer, Société Anonyme, Willebroeck; France, La Compagnie des Forges D'Audincourt. The United States patents are offered for sale by Schuchardt & Schutte, of 90 West street, New York.

Either standard wrought iron or steel tubes can be corrugated by the Maciejewski process. According to the pressure and size required, small and medium-size tubes are made from ordinary steel tubing, while for large diameters lap-welded and rerolled tubes are used. The corrugations are made by an ingenious method of pressing the material together, a special machine being employed, the design and construction of which are fully covered by patents. An important feature in the present process and not found in any other is that, through shortening the tubes, the corrugations are pressed into them at equal distances apart without decreasing the original inside diameter. Furthermore, the thickness, it is claimed, remains absolutely uniform, and is the same as in the original tube. During the process of corrugating any defects in the material at once become apparent.

Interesting examples of corrugated tubes are shown in the illustration. They can be made in all sizes, from 1⅜ inches up to 18 inches, including diameters suitable for use in boilers. Here the average length is about 12 feet, although any other length can be manufactured if required. The tubes for very long lines can be partly corrugated.

Of the many different uses to which Maciejewski's tubes can be employed to advantage the following should be particularly noted: In steam pipe lines the contraction and expansion caused by the steam, and vibrations of the engines, pumps and other units are effectively taken care of by the elastic property of the tubes. Also in firetube boilers a greater heating surface is secured, and the strain is removed to a large extent from the head plate and the combustion chamber. In superheaters the heating surface is increased, and the same is true in radiators for steam and for hot water heating systems. The greatest advantage of all is the use where the space for expansion and contraction is limited and large bends cannot be made, as is the case on steamships.

When steam is turned on or off there is a wide variation in the temperature, hence there is considerable linear movement in the line and its branches to the various units. This move-



ment was taken up by U bends prior to 1890, and later on by expansion joints. Both, however, have their disadvantages, and have been replaced in many large installations in Europe by a length of pipe corrugated by the Maciejewski's process. Tests made by the Association of German Engineers have shown that smooth tubes when bent have a greater elasticity than they should have according to theoretical calculations. The reason for this is that during the process of bending small corrugations are made, which increase the elasticity when expanding and contracting. Thus, when the small corrugations are increased to a height of ten times the thickness of the material the flexibility of the tube is also increased, the corrugations in the throat being pressed together, while those on the periphery are pulled apart. On account of the easy bending properties of corrugated tubes very small radii can be readily obtained having a large amount of elasticity. For instance, a smooth pipe 10 inches in diameter, having a height of 108 inches and an 108-inch throat, has a maximum expansion of 2 inches. A corrugated tube of the same diameter, but only 63 inches high and a 55-inch throat, has an expansion of 5½ inches. Hence a pipe line which has an expansion of 5½ inches would require three bends of smooth pipe with a combined length of about 81 feet, or only one corrugated tube 12 feet long. The advantage in favor of the latter is at once apparent.

Fire Extinguishing and Fumigation by the Harker Process

The Schutte & Köerting Company, Philadelphia, Pa., has acquired the rights to manufacture in the United States the apparatus now known as Harker's fire extinguishing and fumigation apparatus, which makes use of the products of combustion for fire extinguishing and fumigation. With this apparatus connection is made with the boiler smokestack, from which the gases are drawn to the machine, where they are washed and cooled before passing into the compartments to be fumigated, or before being used for fire extinguishing purposes.

Atmospheric air contains about 21 percent of oxygen. Should this oxygen be reduced by about 25 percent to, say, 15 percent of the air, the combustion of all ordinary material

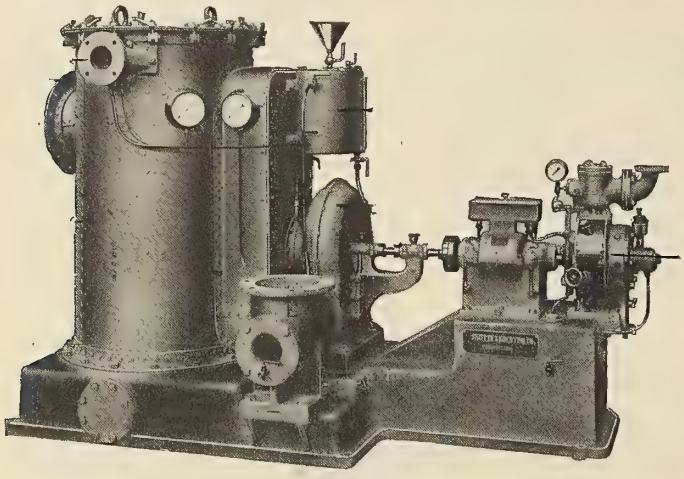


FIG. 1

must cease. It is upon this important fact that the Harker apparatus depends for its ability to put out fire. In burning coal or other fuel in a boiler a considerable portion of the oxygen combines with the fuel; the resulting product of free gas contains about 9 percent of oxygen, and there is, therefore, not sufficient oxygen in this gas to sustain combustion. Therefore, should a fire break out in a ship's hold or other compartment, the compartment may be rapidly filled with the cooled and washed gases, when the fire will be rapidly extinguished. By continuing to force the cooled gas into the compartment the residual heat will soon be carried off, reducing the whole to a normal temperature.

Fig. 1 shows a machine of this type fitted on the steamship *Fiona* and an the American marine tender *Bratton*. Figs. 2 and 3 show the *Fiona* in profile, and indicate diagrammatically the pipe runs for carrying the gases to the various holds. Branches are also led up on deck, terminating in couplings to which flexible hose may be connected, thus enabling the gas to be carried into the various quarters should occasion arise.

The installation on the *Bratton* is used to fumigate all vessels entering the port of Philadelphia. The *Bratton* is run alongside the vessel to be fumigated; flexible hose is carried into the holds, thereby filling them with the gas.

As fitted on these two vessels the apparatus consists of a De Laval steam turbine-driven blower, gas washer and cooler, and an in-take or suction two-way damper. This damper is so arranged that either flue gas or fresh air may be drawn into the machine.

Fig. 4 shows the general arrangement of the latest design of the apparatus, and Fig. 5 shows the same arrangement partly in section in order to illustrate the spray nozzle action. The two-way butterfly valve *V* is arranged with a fresh air in-take *F*, which is screened to prevent papers, etc., from being drawn into the machine. The opening *S* is connected to the smokestack. The gases are drawn from the smokestack through this damper into the cooler *C*, which is divided into a number of chambers, each chamber having a series of spray nozzles, as shown in section, from which water is sprayed in the same direction as the air is traveling. The gases, after being sprayed in four chambers, pass up through the fifth chamber *H*, in which no water is sprayed. They then are carried through the moisture eliminator *E*, which removes any entrained moisture. From thence the gases are delivered to the suction of the turbine-driven blower *B*, and discharged to the various hose connections. The water from the sprays, and also from the moisture eliminator, drains into the base of the washer and is carried overboard through the outlet *O*. In Fig. 4 is shown the disinfector tank, which is arranged in two sections, the upper section being merely a container having a gage glass arranged to show the amount of formaldehyde contained. The lower section is arranged with a pressure gage and safety valve, and inside is a steam copper coil, so that the contents of the tank may be heated and the formalyn driven off under pressure through the pipe *P* into the fan discharge. The lower section of the tank *D* can also be drained to the base. The various spray nozzles are arranged to give a maximum cooling effect. They are connected up to an outside pipe line which takes its supply of water under pressure from a pump.

When operating under good working conditions, burning coal in the boiler, each ton produces about 450,000 cubic feet of free gas. It will be seen, therefore, that an almost unlimited supply of gas is available for fire extinguishing purposes and at little or no cost, as the flue gases are entirely waste product. If fire is found to have broken out the machine can be started up and the boiler fires kept fairly thick and well supplied with coal. If there are any air dampers, such as in the Howden system, permitting air to enter the top of the furnace, these dampers should be closed so that as large a quantity as possible of oxygen in the air may be combined with the coal in combustion.

Flue gases from oil firing are equally effective, as is also the exhaust from internal combustion engines. This latter is very effective, as the quantity of oxygen contained in the gas is exceedingly small.

The Harker system has been objected to on the grounds that the gas might contain carbon monoxide in such quantities as to form an explosive mixture with the air in the hold. To this objection rejoinder is made that if such a liability to explode exists, it ought to show itself when a fireman opens the door of a boiler furnace, allowing a rush of air to mix with the supposed inflammable gas. It is common knowledge, of course, that such an event never happens. Further, by experiment it has been shown that not less than 16 percent of the carbon monoxide must be present with the mixture in the air before explosion is possible, and experiment shows the proportion of flue gas runs generally about 1.5 percent, and has never been known to exceed 5 percent. If the combustion is good it is entirely absent. As a matter of fact, this flue gas is incapable of explosion, as it contains so much inert gas, *i. e.*, nitrogen and carbon dioxide. Further, it has been used to dilute explosive gases, which could then not be exploded.

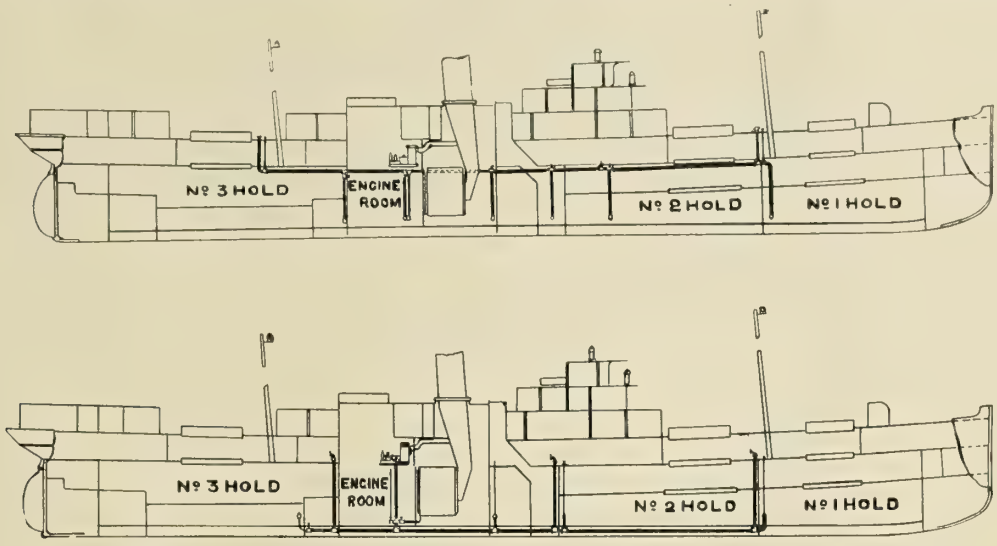
Dr. Harker, in carrying out fumigation with his system, pumped the flue gases into a large number of steamships; and in order to ascertain if the gases had penetrated the various parts, lamps were used, which were immediately extinguished on coming in contact with the gases.

The system has been investigated thoroughly by a specially appointed naval board, and all the tests have been satisfactorily applied and passed. In one test, carried out at Mare Island navy yard, the flue gases were drawn from the uptake of two boilers burning oil.

A quantity of crude oil was placed in a tank and set on fire. While the oil was burning with great force the machine was

started, drawing the gas from the up-take of the boilers through the washers and blowing it into the tank over the burning oil. The flames were instantly extinguished. It was further shown that the gases generated from the hot oil could not be exploded with the flue gas as an atmosphere.

hours, on examination were found to be free from any taint or discoloration. The heat of the gas had melted the butter, but beyond that the butter was in a perfect condition for consumption. The gases are now cooled to such an extent that the possibility of melting such things as butter has been



FIGS. 2 AND 3

As already stated, one of the Harker machines is installed on the United States tender *Bratton*. This machine is in daily use fumigating vessels entering the port of Philadelphia.

The flue gas as it comes from the machine has proven itself of the first order for killing rats, though it will not kill germs or insect life, such as bedbugs and roaches. If, however, a small quantity of formaldehyde or carbon bisulphide is introduced it is claimed that it will kill anything which is to be found alive on board a steamer.

entirely done away with. The fact that these gases have proved absolutely harmless appeals very strongly to ship owners, as the whole ship, including saloons, engine room, staterooms, etc., may be fumigated, no odor being left and no discoloration or damage being done to any of the ship's fabric.

In order to give the gas a distinct odor about ¼ pound of carbon bisulphite, or mustard oil, is added for each 1,000 cubic feet of gas used.

The flexible hose for leading the gas to the holds of the

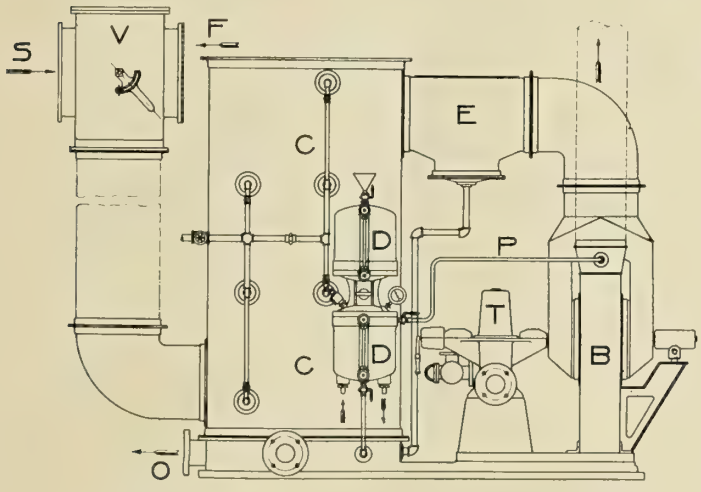


FIG. 4

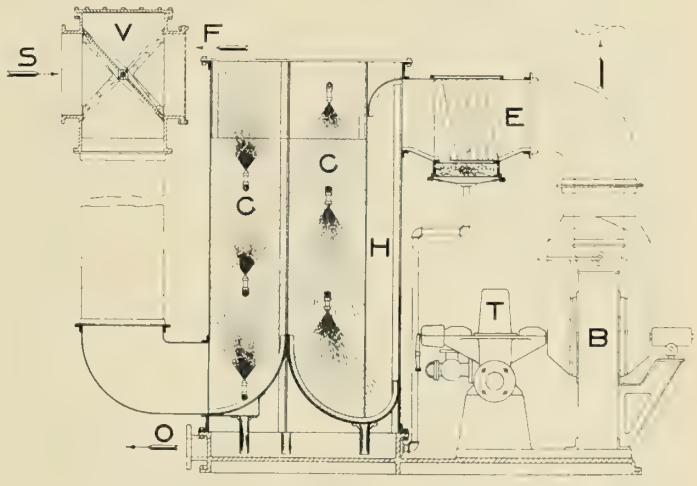


FIG. 5

The *Bratton* is run alongside the vessel to be fumigated, and a flexible hose connected to the discharge of the machine and carried on board the vessel and into the holds to be fumigated. The machine is then started up and the holds filled with gas. The carbon dioxide and nitrogen, of which the gas is principally composed, kills all the rats in a very few minutes, and the formaldehyde, which is introduced through the disinfectant tank, acts as a germicide and raticide.

Extensive tests have been made by bringing the gas into contact with various cargoes. Even such sensitive articles as butter and flour, after having been left in the gases for several

vessels being fumigated is made of spiral phosphor bronze wire covered with canvas. This enables the hose to be easily handled on account of its flexibility and its lightness.

LAUNCH OF 700-TON HOPPER STEAMER.—Messrs. William Simons & Company, Ltd., Renfrew, launched recently a 700-ton hopper steamer complete with all machinery on board and with steam up ready for trials. This is the first of a fleet of eight dredging vessels this firm has on hand for the naval port Emperor Peter the Great, now under construction at Reval by the Imperial Russian Government for warship purposes.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of INTERNATIONAL MARINE ENGINEERING, published monthly at New York, required by the act of August 24, 1912.

Editor, Howard H. Brown; managing editor, H. L. Aldrich; business manager, H. L. Aldrich, all of 17 Battery place, New York.
Publisher, Aldrich Publishing Company, a New York Corporation, 17 Battery place, New York.
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ALDRICH PUBLISHING COMPANY,
H. L. Aldrich, President and Treasurer.

Sworn to and subscribed before me this 2d day of October, 1912.
(Seal) GEORGE E. MULLER,
Notary Public.
(My commission expires March 30, 1915.)

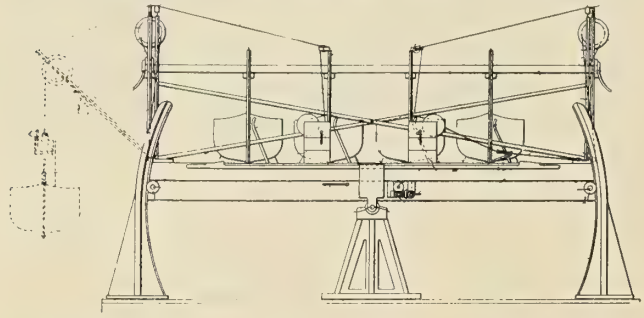
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,059,148. STOWING AND LOWERING AND RAISING SHIPS' BOATS. WILLIAM JOHN GREENFIELD, OF WATERFORD, IRELAND.

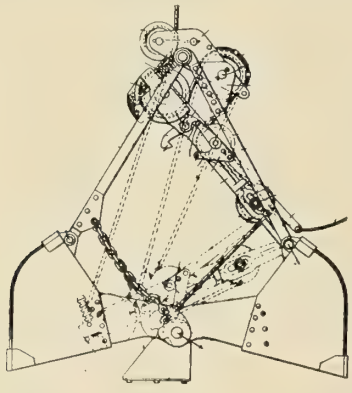
Claim.—An apparatus comprising, in combination, a pivotally-mounted platform disposed athwartship on the deck of a ship and provided with a longitudinal track; means for canting said platform to starboard or port; a traveling cage mounted upon said track for movement theron to



starboard or port when said platform is canted, said cage being adapted to contain a plurality of boats arranged side by side and being provided with rails and trolleys from which said boats are suspended; and tackle for lowering and raising said boats. One claim.

1,062,208. CLAM-SHELL BUCKET. CHARLES S. WILLIAMS, OF CLEVELAND, OHIO.

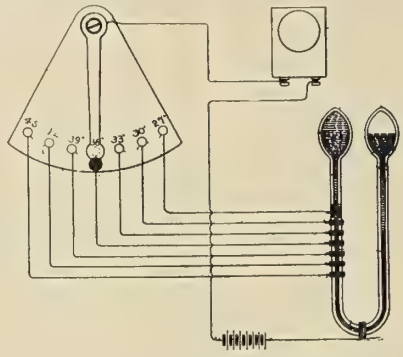
Claim 2.—In a clam-shell bucket, the combination of a frame-member; two oscillatory scoop-members hung from said frame-member; a closing-



member suitably pivoted; means for detachably connecting said closing and scoop-members; sheaves mounted upon said frame-member and closing-member; and a closing-line positively connected with said scoop-members and passing around said sheaves. Seven claims.

1,062,292. AUDIBLE SIGNAL FOR DETERMINING THE TEMPERATURE OF SEA-WATER. ALEXANDER McNAB, OF BRIDGEPORT, CONN., ASSIGNOR TO THE McNAB COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF CONNECTICUT.

Claim 3.—A water temperature annunciator comprising a receptacle, a heat conducting partition dividing the receptacle into compartments, means for admitting water to one of the compartments, means for discharging water therefrom, an expansible liquid thermometer in the other compartment, a plurality of electricity conducting points in the path of contractile movement of the liquid in the thermometer, an insulated support provided with contacts corresponding in number with the points, circuit connections between the points and contacts, a manually operable



switch carried by the support and adapted for selective engagement with the contacts, a battery, an alarm, and a circuit connection between the thermometer, battery, switch and alarm. Nine claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

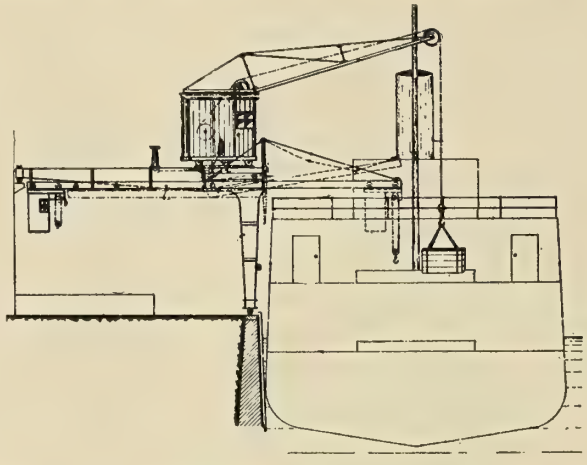
5,493. IMPROVEMENTS IN FRAMES PRODUCED FROM SHEET METAL FOR BULKHEAD DOORS AND THE LIKE. MECHAN & SONS, LTD., AND J. YOUNG MOYES, OF SCOTSTOUN IRON WORKS, SCOTSTOUN, GLASGOW.

This invention relates to the production of a frame produced from sheet metal for a bulkhead door comprising a body applied to lie against the face of the bulkhead and having around its inner rim a continuous

seating flange for the door to be pressed against, the frame having around its outer rim a continuous stiffening flange extending from the body of the frame and projecting away from the face of the bulkhead. The flanges may be formed with webs, or may be otherwise shaped.

17,349. A LOADING DEVICE ESPECIALLY FOR OPERATION ON HARBORS. DEUTSCHE MASCHINENFABRIK A. G., OF DUISBURG, GERMANY.

Claim.—A loading and discharging apparatus, more especially for use upon wharves for handling ships' cargoes, by which the loads can be raised and moved along a circular or straight path, comprises the com-



bination of an overhead traveler and a slewing crane, the overhead traveler having a movable extension member adapted to be projected beyond the end of the traveller in order to lengthen the track and thus to increase the working range of the crab or hoisting mechanism, the traveler being supported at its end in such manner as to permit the passage of the crab or hoisting mechanism either unloaded or loaded to and from the extension member. The movable extension member of the traveler is adapted for use as the jib of a slewing crane, mounted above the traveler.

5,804. IMPROVEMENTS IN THE CONSTRUCTION OF SHIPS. G. M. HARROWAY, OF PARKSIDE, MIDDLESBROUGH, YORK.

The object of this invention is to so construct ships as to improve their stability. The beam of the ship is increased at about the load line and extends vertically upwards to the free-board deck line and angularly downwards, where it merges into the normal beam of the ship. The cubic capacity of the ship at each side is increased, the additional reserve buoyancy enabling the ship to be loaded to a deeper draft by carrying additional cargo.